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ABSTRACT

This report examines the representation of women and minorities in the science, mathematics, and engineering fields and addresses the sources of current trends and issues for the future. The first section, "Demographics and the Science and Engineering Talent Pool", addresses the expected shortfall of more that 400,000 science and engineering personnel by the year 2000 and the general demographic changes eroding the science and engineering workforce. A section titled "The Topography of the Educational Pipeline for Minority Students" looks at school systems and curricula, teacher perceptions of students, student attitudes, and the performance of minority students in the precollege curriculum. The third section, "Enrollment in Science and Engineering Minority Groups: Trends by Gender and Ethnicity", discusses Blacks, Hispanics, Native Americans, and women. The following section, "Participation of Minorities in Higher Education", describes factors affecting participation, shortages of minority faculty and administrators, the historically Black institutions, the major research universities, and liberal and community colleges. A section titled "Programs and Strategies for Minority Student Enrichment" covers federal and state involvement and privately sponsored programs. A final section outlines policy issues. Statistical data are presented in 8 tables and 3 graphs and 205 references are provided. (JB)

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CRS Report for Congress

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Underrepresented Minorities and Women in Science, Mathematics, and Engineering: Problems and Issues for the 1990s

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U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
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UNDERREPRESENTED MINORITIES AND WOMEN IN SCIENCE, MATHEMATICS, AND ENGINEERING: PROBLEMS AND ISSUES FOR THE 1990s

SUMMARY

The Bureau of the Census reports that the population base from which future scientists and engineers are taken will have a significantly different racial mixture from that of the past. By the year 2000, approximately 85 percent of the new entrants to the U.S. labor force are expected to be minorities, women, handicapped, and immigrants, groups which for the most part have been historically underrepresented in science, mathematics, and engineering. Presently, blacks and Hispanics are 25 percent of the precollege level, and, by the year 2000, they will comprise 47 percent. Approximately 23 of the 25 largest school systems in the United States are majority minority school systems--systems in which students from minority groups predominate.

As groups, minorities, particularly blacks, Hispanics, and women have traditionally been underrepresented in the science, mathematics, and engineering disciplines compared to their fraction of the total population. Asian Americans are not statistically underrepresented in science, mathematics, and engineering, and as a consequence, are excluded from this report. In 1988, blacks accounted for 2.6 percent of all employed scientists and engineers; Hispanics were 1.8 percent; and women were 16 percent. Poor preparation in science and mathematics is said to be a major factor limiting the appeal of and access to science and engineering for these groups and increasing the attrition among those who do study the sciences. In addition, data at the precollege level show that women take fewer years of science and mathematics coursework (including advanced studies) than men. However, not only are some minority students experiencing disparities in preparation, they also are given disparate levels of academic competition and deficient exposure and interaction with people who have attended or plan to attend college, and as a consequence, lack knowledge of the value of a college degree.

There has been positive movement in the performance of minority students in science proficiency. Educational Testing Service (ETS) data indicate that from 1977 to 1986, 9- and 13-year-old black and Hispanic students showed gains on science proficiency while the white student population evidenced only slight improvement. For the 17-year-old population, a decline in science proficiency was recorded from 1977 to 1982 for black, white, and Hispanic students. However, these same groups witnessed increases from 1982 to 1986. For women, science proficiency showed gains for 9- and 13-year-olds from 1977-1986, but remained at the same level for 17-year-olds. Additional data have found that, when the requisite quantitative ability was maintained in high school, minority students persisted in science and mathematics at a level equal to or higher than comparable nonminority students.

These demographic phenomena may affect the development of the scientific and engineering workforce and, consequently, the conduct of research and development in the 21st century. The role of minorities is no longer viewed just as an equity issue; the demands of a scientific and technical workforce must also be met.

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UNDERREPRESENTED MINORITIES AND WOMEN IN SCIENCE, MATHEMATICS, AND ENGINEERING: PROBLEMS AND ISSUES FOR THE 1990s

INTRODUCTION

What forces persist in the general culture, in the general values system of American society, in the family, in the school system, and in the media that have failed to attract a significant number of minority women and students to the sciences?[1] Minorities, who, historically, have been underrepresented in the sciences, are the ones who have had the least financial resources and support systems. Many minorities, also, have had inequitable educational backgrounds when compared with their nonminority counterparts. The underrepresented minorities discussed in this report include blacks, Hispanics (Mexican Americans, Puerto Ricans, Cubans), Native Americans (Aleuts, Eskimos, Alaska Natives), and women.[2] While Native Pacific Islanders (Polynesians and Micronesians) and the handicapped are underrepresented, they will not receive focus. Asian Americans are excluded in this report primarily because they are not statistically underrepresented in science, mathematics, and engineering.[3] Data from the National Science Foundation (NSF) for 1988 reveal that, while Asian Americans are approximately 2 percent of the U.S. workforce, they account for more than 5 percent of the total science/engineering workforce.[4] Additional data show that Asian representation among doctoral scientists and engineers is greater than their representation among all scientist and engineers.[5] Rigorous demands are now being placed on the U.S. educational system to broaden the pool of minority students at the precollege level so as to affect college

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[1] The terms science; science, mathematics and engineering; and science and technology, are used interchangeably in this report to describe a taxonomy of degree fields. The subfields of science, as defined by the National Science Foundation, are the physical sciences, earth, atmospheric and marine sciences, life sciences, biological sciences, social sciences, psychology, mathematics, and computer/informational sciences. When noted, selected subfields, of the sciences will be discussed.

[2] Women are included and are treated in this report because they are subject to the same protection against discrimination under Title 7 of the 1964 Civil Rights Law (42 USC, section 2,000 et seq).

[3] According to one writer as a minority group, Asian Americans are: ". . . funneled into science out of all proportion to any other ethnic group--pressured to go there by a combination of forces including family and societal preconceptions about what Asian can excel in, as well as university hiring policies that have failed to provide Asian American role models in non-science disciplines." Buderi, Robert. Berkeley's Changing Student Population. Science, v. 245, Aug. 18, 1989. p. 694.

[4] U.S. National Science Foundation. Women and Minorities in Science and Engineering. Jan. 1990. NSF 90-301. p. 30.

[5] Ibid.

enrollment, college success, and college graduation. The system needs to focus on the largest tier of minority students, those not necessarily with the high standardized test scores, yet still possessing the demonstrateyd ability from other measures to succeed in science, mathematics, and engineering. The problem of underrepresented minorities in the sciences is serious enough to compromise the United States ability to develop and advance its traditional industrial base and to compete in international marketplaces. This report will discuss selected social, educational, and economic factors that influence the decisions of minorities and women to pursue careers in science, mathematics, and engineering, along with policy options that contain provisions to address these areas of concerns.

DEMOGRAPHICS AND THE SCIENCE AND ENGINEERING TALENT POOL

Any attempts by scientists and educators to address the expected shortfall of more than 400,000 science and engineering personnel by the year 2000 (estimate of the National Science Foundation) would be expected to include recognizing the general demographic changes that are eroding the science and engineering workforce.[6] The number of college age students is declining: this is expected to continue through 1996. After that time, the projections are for a rise back to the 1983 level by the year 2008. According to impending demographic realities, during the trough of the decline, 1994-1996, fewer people may be available to go into scientific and technical careers. Also, the number of students electing majors in science and engineering is decreasing. It is thought that the talent pool reaches its maximum size prior to high school, however, migration into the pool is evident during grades 9 through 12. When migration does occur after high school, it is more likely to be out of, rather than into the pool.[7]

A survey conducted by the American Council on Education in conjunction with the Cooperative Institutional Research Program of the University of California, Los Angeles, found that in 1988, approximately 15.3 percent of entering freshmen selected sciences as majors (biological sciences, physical sciences, mathematics, and engineering), a decrease from 15.4 percent in 1987,

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[6] Atkinson, Richard C. Ominous Statistics Foretell Drastic Shortage Of Scientists. The Scientist, v. 4, June 25, 1990. p. 11.

[7] Berryman, Sue E. Who Will Do Science? Columbia University. National Center on Education and Employment. An occasional paper with the support of the Rockefeller Foundation. New York, 1983. p. 7.

18.1 percent in 1980, and 21.3 percent in 1966.[8] Freshmen interest in computer science in the fall of 1988 was unchanged from its 1987 level of 2.7 percent, but remained below its 1982 level of 8.8 percent.[9] It should be noted that interest in engineering registered a marginal increase in 1988, to 8.6 percent from 8.5 percent in 1987, but well below its peak of 12 percent in 1977.

The size of the population base from which new scientists and engineers are taken yields some information about supply potentials. The Bureau of the Census, U.S. Department of Commerce, reports that since 1982, the population of 22-year-olds has declined, and is forecasted to continue in this direction through the year 2000. The Bureau projects that a marked decline will occur during 1996-1998, at which time the number of 22-year-olds will be approximately 25 percent less than in 1982. Such future projections are cause for concern for some educators because of the strength of past linkages between the number of 22-year-olds and undergraduate science and engineering degrees.

In addition to lower numbers, the prospective 22-year-old pool will have a significantly different racial mixture than the past. The Bureau of the Census reports that in 1975, 14 percent of the 22-year-old population was composed of minorities; by 1995, the projected percentage will be 19 percent, and by the year 2005, 20 percent.[10] Presently, blacks and Hispanics are 25 percent of the precollege level population, and, by the year 2000, they will comprise 47 percent (this change has already occurred in California, Texas, and New Mexico).[11] If current trends continue, by the year 2020, today's minorities will become the

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[8] Astin, Alexander W., Kenneth C. Green, William S. Korn, Marilyn Schalit, and Ellyne R. Berz. The American Freshmen Norm: National Norms for Fall 1988. Prepared by the Cooperative Institutional Research Program, and sponsored by the Higher Education Research Institute, Graduate School of Education, University of California, Los Angeles, and the American Council on Education, Dec. 1988. p. 6.

[9] Ibid.

[10] Between the years 1980 and 1989, the Hispanic population grew by 39 percent, the Native American population grew by 22 percent, the black population grew by 14 percent, while the white population grew by only 7 percent. Center for Demographic Policy. Demographics for Education Newsletter, v. 1, June 1990. p. 1.

[11] The Challenge to the Business Community. Congressional Testimony on Its Stake in the Education of At-Risk Children. The Institute for Educational Leadership, Inc. Washington, 1987. p. 6.

majority of students in the United States.[12] Although there has been an increase in the participation of minorities in the science and engineering disciplines at the undergraduate level, it is over such a small base that the significance is muted. Questions are raised as to whether even the present low participation of non-Asian minorities in the sciences can be maintained, and, more importantly, can be increased in the coming years.

Demographic patterns will alter the size and composition of the high school graduating classes. Approximately 23 of the 25 largest school systems in the United States are majority minority school systems--systems in which students from minority groups predominate.[13] The Hispanic population growth is to be the fastest growing of all groups, primarily due to immigration, with black population growth following as second. By the year 2000, minority groups are projected to constitute the majority of the population in 53 major cities.[14] However, today, a smaller proportion of minorities age 18 to 24 than of non-minorities has graduated from high school, and the college-going rates for those minorities who do graduate also is lower than those for non-minority high school graduates.

As a group, minorities, particularly blacks and Hispanics, have traditionally been underrepresented in the science and engineering disciplines compared to their fraction of the total population. Blacks are approximately 12 percent of the U.S. population and constitute 2.6 percent of all employed scientists and engineers. Hispanics comprise 9 percent of the U.S. population, and represent less than 2 percent of all employed scientists and engineers.[15] Black enrollment in science and engineering alone has declined 19.5 percent since 1981. Concomitant with the underrepresentation and the recent downturn, blacks' and Hispanics' "persistence rate" in the sciences (continuing in the program until graduation) has been 29 percent as compared to the national total of 79 percent. Poor preparation in science and mathematics is said to be a major factor limiting the appeal of and access to science and engineering for these

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[12] Presently blacks are the majority of the population in Atlanta, Baltimore, Detroit, and Washington, D.C. The dominant population in the cities of El Paso, Miami, and San Antonio is Hispanic. In less than 20 years, whites will no longer claim a state-wide majority in Texas and California. Hodgkinson, Harold L. Director. Center for Demographic Policy, Institute for Educational Leadership, Inc. Speech given before Carnegie Foundation sponsored conference on The Generational Contract: Educating All Our Youngsters for the 1990s. Washington, June 26-28, 1989.

[13] Woodside, William S. Corporate Leadership for Public Education. The Institute for Educational Leadership, Inc. Washington, May 1986. p. 6.

[14] U.S. Dept. of Labor. Workforce 2000. Prepared by the Hudson Institute for the Dept. of Labor. Washington, U.S. Govt. Print. Off., 1987. p. 95.

[15] Women and Minorities in Science and Engineering Education, p. 28, 149-150.

groups and increasing the attrition among those who do study the sciences. However, not only are some minority students experiencing disparities in preparation, they also are given disparate levels of academic competition and deficient exposure and interaction with people who have attended or plan to attend college, and as a consequence, lack knowledge of the value of a college degree. Shirley M. Malcom, Head, Directorate of Education and Human Resources Programs, American Association for the Advancement of Science, testified before the Senate Committee on Labor and Human Resources that:

> Underrepresented minority students are less likely to be in the academic track in high school, less likely to participate in programs for the gifted and talented and are more likely to be in remedial programs. . . . Since less is being provided, students are denied the opportunity for exposure to more rigorous content and concepts which are usually precursors to more advanced work in high school. Evidence is emerging from studies by Jeannie Oakes of The Rand Corporation that schools which minority students attend are more likely to have less able teachers and less rich course offerings.[16]

These issues coupled with demographic projections may affect the development of the scientific and engineering workforce and, consequently, the conduct of research and development (R&D) in the 21st century. The international competitiveness of many U.S. industries depends not only on macroeconomic policies but on building capable and scientific and technological workforce. Effective science and mathematics education is needed to prepare the students who will become the Nation's scientists and engineers, and greater technical literacy is needed by citizens generally in an increasingly complex and competitive world.[17] The U.S. technological position currently appears to be threatened by a possible shortage of scientists and engineers, and even more important, by the lack of general scientific and mathematical literacy required by the people who are primarily responsible for quality and productivity gains. Even students pursuing nonscientific and nonmathematical specialties are likely to require basic knowledge of scientific and technological applications for effective participation in the workforce. There is likely to be a need to expand

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[16] U.S. Congress. Senate. Committee on Labor and Human Resources. Crisis in American Math, Science and Engineering Education. Hearings, 101st Cong., 1st Sess., Nov. 14, 1989. Washington, U.S. Govt. Print. Off., 1990. p. 35-36.

[17] U.S. Congress. House. Committee on Science, Space, and Technology. Subcommittee on Science, Research, and Technology. Scientific, Technical and Literacy Education and Training and H.R. 3122, the Science and Technological Literacy Act. Testimony of Raymond J. Uhalde, Deputy Administrator, Office of Strategic Planning and Policy Development, Employment and Training Administration. U.S. Dept. of Labor. Hearings, 101st Cong., 1st Sess., Oct. 31, 1989. Washington, U.S. Govt. Print. Off., 1990. p. 100.

and diversify the Nation's science and engineering workforce at all levels. The role of minorities is no longer viewed just as an equity issue; the demands of a scientific and technical workforce must also be met. W. Ann Reynolds, former chancellor, California State University, speaking before the Committee on Science, Space, and Technology hearings on Women, Minorities and the Disabled in Science and Technology stated that:

> . . . [T]he role of minorities, women, people with disabilities, is not an equity issue. The need for women, minorities, in science and engineering is quite simply a nationwide work force issue. The Nation's leadership in science and engineering cannot be maintained, cannot survive, I would submit, unless our education pipeline receives the help it needs to create a more diverse group of world-class scientists and engineers.[18]

Some in the scientific community, however, conclude that the projected shortages in science and engineering personnel will not occur. They charge that career choices and market forces are more indicative of the future supply of scientists and engineers than are demographics determinants. They point out that past predictions of long-term shortages and surpluses have failed to materialize. Alan Fechter, Executive Director, Office of Scientific and Engineering Personnel, National Academy of Sciences, stated that debate should not focus on whether there is a projected shortage, but on the ". . . nonwhites and nonmales, the numbers of foreign nationals and the numbers of women and minorities in science and engineering. There is an excess of some and a scarcity of others."[19]

THE TOPOGRAPHY OF THE EDUCATIONAL PIPELINE FOR MINORITY STUDENTS

Local School Systems and Their Curricula

The public schools are the critical determinant of students' preparation; however, for some minorities, the school experience can inhibit satisfactory academic achievement. Rigorous demands are being placed on the approximately 16,000 school districts in the U.S. educational system. The education pipeline of today is more diverse than the past and presents more challenges for the school system. Data indicate that in the freshman class of the year 2000, comprised of the children born in 1982, approximately 35 percent are black,

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[18] U.S. Congress. House. Committee on Science, Space, and Technology. Women, Minorities, and the Disabled in Science and Technology. Hearing, 100th Cong., 2d Sess. Washington, U.S. Govt. Print. Off., 1988. p. 14.

[19] U.S. National Science Foundation. Education and the Professional Workforce. Mosaic, v. 18, Spring 1987. p. 15.

Hispanic, Native American or Asian, approximately 25 percent are in homes labeled impoverished, more than 14 percent are the children from unmarried parents, 10 percent have functionally illiterate parents, 15 percent are children who had English as a second language, 12.5 percent are mentally or physically handicapped, and approximately 50 percent are estimated to live in a single parent household prior to the age of 18.[20] Presently, approximately 50 percent of black children, 40 percent of Hispanic youth, and approximately 70 percent of Native American children under the age of 18 years are raised in families living at the poverty level (the Federal poverty line for a family of three is $9,056).[21] The sobering reality is that some of these students, specifically minority students, have experienced measurable amounts of neglect and indifference. This neglect and indifference is coupled with a fractionalized educational system in which equal educational opportunities are nonexistent. A 1988 report of the Educational Testing Service stated that: "Students do not arrive at the kindergarten door with equal opportunities and aspirations. Social and economic realities have begun to have an impact long before that time, and school does not serve to eradicate these inequities."[22]

There are stark differences between student performance in urban systems with a large minority population, and suburban systems with less of a minority population. One reason for lower performance and achievement in urban areas is limited resources. Many urban school districts spend less per capita on each student than suburban districts, and suburban students are more often exposed to more educational opportunities than urban students.[23] James Vasquez,

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[20] Vetter, Betty M. Recruiting Doctoral Scientists and Engineers: Today and Tomorrow. Occasional Paper 89-2. Commission on Professionals in Science and Technology. Adapted from a presentation on Sept. 19, 1988, to General Electric Doctoral Recruiters, General Electric Company. p. 16; and Demographics for Education. Center for Demographic Policy. CDP Newsletter. The Demographics of School Reform: A Look at the Children, v. 1, Mar. 1990. p. 1-2.

[21] Educating Black Youth Means Addressing a Range of Concerns. Southern Education Foundation News. Jan. 1990, v. 4, p. 4; Changing America: The New Face of Science and Engineering. Final Report. The Task Force on Women, Minorities, and the Handicapped in Science and Technology, Dec. 1989. p. 22; and Locke, Patricia. American Indian and Alaska Native Education Issues. Prepared for the Rural Education Conference "The Rural Agenda of Educating All Children for the 1990s." May 12, 1989.

[22] Educational Testing Service. The Science Report Card: Elements of Risk and Recovery. Trends and Achievements Based on the 1986 National Assessment. Report No: 17-S-01, Sept. 1988. p. 7.

[23] Baker, Peter. Poor Schools Grow Poorer, Va. Study Says. The Washington Post, Jan. 26, 1990. p. C6; and Maraniss, David. Texas Schools' Financing Ruled Unconstitutional--Court Orders Lawmakers to Find Alternative. The Washington Post, Oct. 3, 1989. p. A14.

Superintendent of Edgewood school district, San Antonio Texas, notes that, generally, the urban school systems ". . . have the most kids, the most pressing needs, and the poorest tax bases."[24] In addition, while some urban districts must do more with less funding, all students are evaluated on the same criteria--similarly Iowa Test of Basic Sills, Stanford Achievement Tests,California Test of Basic Skills, Scholastic Aptitude Test, (SAT), the American College of Testing (ACT), and the National Collegiate Athletic Association Proposal (NCAA) 48.[25] In many urban areas, where minority students are concentrated, dropouts rates for minority students reportedly exceed 50 percent by the ninth grade.[26]

Suggestions have been made that local school systems must make a conscious effort at curriculum restructuring, yet many school systems have failed to create a learning environment that is structured and stratified to meet the diverse needs of the student population. The heightened interest among educational researchers in curricula reform, especially in the areas of the sciences, has become very acute for minority students. School systems could make science and mathematics more attractive to all students, including those members of minority groups with potential talent and inclination for technology-based careers. It has been proposed that systems support an educational model that will enlarge the population of students into science careers, that would "broaden the pool" rather than "skimming the cream."[27] Bill G. Aldridge, Executive Director, National Science Teachers Association (NSTA), states that the pool of students in science would be expanded if the science curriculum focused resources and attention on all students to take more science courses. Such an approach would effect a more diverse group of scientists that presently exists. He constructs an analog between the need for including *all* students in the science education program and molecular motion.

> The present state of secondary school science is like the first state of the gas. We select the young people who happen to be moving fastest in the "right" direction, and we ignore even faster

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[24] Maraniss, David. Texas Schools' Financing Ruled Unconstitutional--Court Orders Lawmakers to Find Alternative. Washington Post, Oct. 3, 1989. p. A14.

[25] Proposal 48 of the National Collegiate Athletic Association is defined by Bylaw 5-1-(j) partial qualifier. Proposal 48 requires that entering student athletes have a minimum of 2.0 grade point average in a core curriculum of 11 high school courses, and a minimum combined SAT score of 700 or ACT of 15. Because of the order in which this proposal has been presented in the Association's annual meetings, it also carries the designation of Proposal 42 and Proposal 26 (the most recent).

[26] Wiley, Ed III. Tracking/Labelling Key Reasons for Declining College Pool, Researcher Suggests. Black Issues in Higher Education, v. 6, July 20, 1989. p. 1.

[27] Aldrige, Bill G. Essential Changes in Secondary Science: Scope, Sequence and Coordination. Dec. 16, 1988. p. 1.

> (more able) children who do not happen at that moment to be moving in the "right" direction. We give those selected students the added push (advantage in the form of resources, teacher attention, and recognition); and we ignore the rest of the students.
>
> There is another way of making fast molecules move toward the opening. If you heat the entire sample of molecules, all will move faster. The fastest will be even faster than before, and more molecules will pass through the opening. And you've accomplished this without selecting certain molecules or giving only them special assistance.
>
> Heating the gas is analogous to providing more and better science education for *all* children so they can *all* move faster. Many of them will move in the "right" direction, but not necessarily at the time we want them to do so. If we allow for this delay, we will reap a rich selection of students in science, just as we got a greater variety of molecules in the heated gas.[28]

The importance of restructuring schools was included on the agenda of the September 1989 education summit at the University of Virginia with the Nation's Governors, hosted by President Bush. The consensus of the summit was that fundamental restructuring would be done at the State and local level. A January 1990 report of the Quality Education for Minorities Project at the Massachusetts Institute of Technology, ***Education That Works: An Action Plan for the Education of Minorities,*** supported fundamental restructuring also, positing that it was vital relative to minorities. The report declared that:

> Efforts at restructuring must value minority students; assume responsibility for their learning; be sensitive to their backgrounds, language, and cultural values; and be adequately funded. Any national goals for education, such as those to be proposed by the governors in 1990, must include a vision to improve the education of our students.[29]

In addition, the report found that the bulk of minority students continue to attend schools that remain separate and unequal.

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[28] Aldridge, Bill G. Drastic Changes Needed in Secondary School Science Education. The Generational Journal, v. 2, Apr. 30, 1989. p. 21.

[29] Quality Education for Minorities Project. Massachusetts Institute of Technology. Education That Works: An Action Plan for the Education of Minorities. Cambridge, MA., Jan. 1990. p. 3.

> Forty-four years after *Mendez v. Westminster School District*, and thirty-five years after *Delgado v. Bastrop Independent School District*, and thirty-five years after *Brown v. The Board of Education of Topeka*--all cases that declared segregated school unconstitutional--most minority children remain in schools that are separate and decidedly unequal. Educational opportunities for most minority youth lag behind those available to white students, and that lack of opportunity is reflected in the lower educational achievement of minority children.[30]

More recently, Lauro F. Cavazos, Secretary of the Department of Education, in the release of ***The Writing Report Card, 1984-88*** **and** ***The Reading Report Card, 1971-88,*** **stated that the education reforms of the 1980s have failed to raise the achievement scores of the students, markedly.**[31] Both reports proposed major structural changes in the U.S. educational system.

One criticism of many school systems has been their continued tracking of students. These mechanisms have been ineffectual.

> . . . [r]esearch findings consistently indicate that inflexible track placements and rigid ability groupings segregate, stigmatize, and deny those in the bottom tracks the same access to quality education those in the upper tracks receive . . . .[32]

While minority high school completion rates have improved in the past years, minority students remain significantly overrepresented in the vocational tracks and underrepresented in academic programs. Clifton R. Wharton, former chancellor, State University of New York, has argued that teachers and counselors have engaged in the frequent practice of counseling minority

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[30] Ibid., p. 1.

[31] Educational Testing Service. The Writing Report Card, 1984-88: Findings from the Nation's Report Card. The National Assessment of Educational Progress. Prepared under a grant from The National Center for Education Statistics. Princeton, N.J., Jan. 1990. 110 p.; and The Reading Report Card, 1971-88: Trends from the Nation's Report Card. The National Assessment of Educational Progress. Prepared under a grant from the National Center for Education Statistics. Princeton, N.J., Jan. 1990. 67 p.

[32] Visions of a Better Way: A Black Appraisal of Public Schooling. Committee on Policy for Racial Justice. Joint Center for Political Studies. Washington, 1989. p. 36.

students into trade and vocational curricula, with the tacit assumption that they are not capable of the more rigorous academic alternatives.[33]

The sequencing of science courses and tracking of students preclude many students from later selecting science as a career while augmenting the advantages for some students. Minority students (primarily black and Hispanic) are disproportionately placed in the low-ability or non-college bound tracks, which merely reinforces educational inequalities.[34] Such practices are manifested even though ". . . [d]ifferences in placement by race and social class appear regardless of whether test scores, counselor and teacher recommendations, or student and parent choices are used as the basis for placement."[35] High school science courses are duplicated in many of the introductory college courses. Students who have taken high school science courses, are better in freshmen science courses and score higher on entrance exams. They are perceived as having higher abilities by their professors, and are given scholarships and opportunities to do research related work with the best faculty. Those students who did not take high school science courses are at a disadvantage. Aldridge of the NSTA stated that:

> The present sequencing of courses and tracking of students reinforce the accumulation of advantage for some students and effectively preclude others from later selecting science as a career. A child who has not enrolled in algebra in the eighth or ninth grade and then not taken the other more advanced math courses in sequence is not ready for the series of advanced science courses required in high school. As a result, a student is ruled out from majoring in one of the physical sciences or engineering fields in college.
>
> High school physics, chemistry, and biology course duplicate substantial portions of introductory college courses. Young people who take these high school courses enter college with prior knowledge of the subjects, and they also score higher on entrance exams. They therefore are perceived as having higher ability. They are given scholarships and opportunities to study under the best faculty, so that their prior advantages are rewarded, leading them to continue in these science fields.

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[33] Wharton, Clifton R. The Minority Student Challenge. Science, v. 224. June 1, 1984. p. 937.

[34] Shaping Higher Education's Future: Demographic Realities and Opportunities, 1990-2000. Arthur Levine and Associates. San Francisco, 1989. p. 65.

[35] Oakes, Jeannie. Keeping Track, Part 1: The Policy and Practice of Curriculum Inequality. Phi Delta Kappan, Sept. 1986. p. 14.

> Young people who did not take those courses in high school, but later show interest, are at such a disadvantage that without special assistance or extraordinary motivation and hence, they will never be able to compete successfully with their more advantage peers. Since such disadvantage in the physical sciences is often associated with women and minorities, it is not surprising that we find their numbers disproportionately low among engineers and physical scientists.[36]

The economy requires a significantly larger number of highly skilled and educated workers. Experts says that schools must make the necessary changes to provide effective educational experiences to a broader range of students, and this can be done without compromising quality. According to these experts, both informational and motivational experience need to be provided that will promote the prospects of post-secondary education for minority students and those students at risk. These groups of students need to be able to find success and positive learning experience in early grades that will enable them to move through a series of transitions resulting with multiple options at the secondary level. Policies and programs of local school systems that are designed to keep all children in the pipeline for a longer period of time, benefit the Nation at large. Furthermore, any efforts at curriculum improvement must be sustained in order to assure lasting change and improvement.

Teachers Perceptions of Students

While such variables as ability, academic preparation, and level of motivation contribute significantly to educational achievement, classroom teaching and teacher expectation also serve as a significant determinant in the quality of educational opportunity. However, some minorities receive discrimination and discouragement not only from their peers, but also from a predominant teacher population and the absence of role models. At present, approximately 16 percent of the Nation's elementary and secondary public school students are black, yet only 7 to 8 percent of the teachers in these public schools are black.[37] In 1986, less than 5 percent of the 2,200 teachers hired in the Los Angeles Unified School district, a school district that is 52 percent Hispanic, were Hispanic.[38] By the year 2000, approximately 40 percent of the Nation's pupils will be minorities,

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[36] Ibid.

[37] Visions of a Better Way: A Black Appraisal of Public Schooling, p. 14.

[38] Haberman, Martin. Alliances Between 4-Year Institutions and 2-Year Colleges Can Help Recruit More Minority Students into Teaching. The Chronicle of Higher Education, July 27, 1988. p. A28.

while approximately 95 percent of their teachers will be white.[39] A predominantly white female population will continue to teach this increasingly pluralistic, challenging population. Harold W. Stevenson, Chuansheng Chen, and David H. Uttal, in a study of 3,000 first, third, and fifth grade black, white, and Hispanic students enrolled in Chicago metropolitan area schools, found that minority students did not get equal feedback from their teachers as that which was given nonminority students.[40]

> They [teachers] praised the children for a modestly good performance instead of pushing them to do even better. Then, when the children enter high school, they find they are not prepared for the more difficult work.[41]

The researchers found that while the minority students received disparate feedback in the classroom, they were as equally enthusiastic about education and had equally high expectations about future success as the nonminority students.

A significant number of minority children attend schools in urban areas where the needs of the students and the schools are greater and more immediate. In these urban communities, where racial isolation persists and assimilation into the majority culture is minimal, many of the students' learning troubles result from lack of "cultural synchronization" with their middle class white teachers. Educational researchers and practitioners have strongly urged that more minority teachers be trained and recruited to teach in these areas.[42]

For more than 20 years, educational research has shown a direct correlation between expectations for student achievement and the types of instruction and counseling provided to the students. Black and Hispanic and Native American students have received considerably less encouragement to pursue scientific and

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[39] Watkins, Beverly. Colleges Urged to Train Future Schoolteachers to Deal with Expected Influx of Immigrants. The Chronicle of Higher Education, v. 36, Dec. 13, 1989. p. A42.

[40] Stevenson, Harold W., Chuansheng Chen, and David H. Uttal. Beliefs and Achievement: A Study of Black, White and Hispanic Children. University of Michigan, 1989. 36 p. [unpublished]

[41] Behavior Today, Mar. 20, 1989, p. 6.

[42] Watkins, Beverly. p. A42; and Conciatore, Jacqueline. Shortage of Minority Teachers Leads Some to Look to Majority. Black Issues in Higher Education, v. 7, July 19, 1990. p. 8-9.

technical careers than white students.[43] Wharton charges that increased efforts should be instituted to better pair minority students with supportive academically oriented surroundings. He asserts that:

> We must also interdict the "cycle of avoidance," in which lack of preparation in basic science and mathematics leads to a lack of interest, anxiety, and ultimately non-enrollment in those fields at the college level. Indeed, high schools and colleges must cooperate to develop academic and career paths in science and technology for promising minority students. To do that, we have to interest these youths during the early secondary years in high-demand professional and technical fields and to provide both special study options and financial incentives to take advantage of them.[44]

Students' Attitudes

Science and mathematics have been described as unpleasant experiences by many students. Having failed on numerous occasions, many students lack the encouragement to continue and so quit.[45] If a student cannot identify with success, often failure remains. Far too often, a students previous performance is the only criteria used to predetermine their level of success.

Performance of Minority Students in the Precollege Curriculum

Students' interest in high school science is not a "fixed notion." At each juncture in the education system, a significant number of minority students are lost. The fundamental failures in elementary and secondary education are more pronounced for black males than any other subgroup of minorities. While black males constitute approximately 17 percent of the public school population, they

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[43] Thomas, Gail E. The Access and Success of Blacks and Hispanics in U.S. Graduate and Professional Education. A working paper prepared for the Office of Scientific and Engineering Personnel, National Research Council. Washington, 1986. p. 31.

[44] Wharton, Clifton R., Jr. The Minority Student Challenge. Science, June 1984. p. 1.

[45] Pearson, Willie Jr. and H. Kenneth Bechtel. Blacks, Science, and American Education. Rutgers, the State University. New Brunswick, N.J., 1989. p. 23-25, 45-48, and Brown, S. A Study of Losses in the Educational Pipeline and Scientific Talent Pool: A Report to the Government-University-Industry Research Roundtable. National Research Council, Office of Scientific and Engineering Personnel. Washington, 1986.

represent 41 percent of the special education classes.[46] These black males get lost early and fail to get into the "pipeline." Increased efforts need to focus on retention by improving the rates of high school graduation for this cohort to enable them to have career choices.

Underpreparation in science and mathematics is a pervasive problem for minority students, with minority students enrolling in fewer science and math courses than their white counterparts. Research has found that early preparation and commitment to science and mathematics is very important, especially for minority students.[47] In a study by Thomas L. Hilton and Valerie E. Lee, it was found that:

> . . . [F]ortifying high school mathematics and science preparation, while introducing young people to the intrinsic interest of these fields above and beyond the drudgery which typifies their perception, would have better social payoff than subsequent efforts to entice undergraduates into [science,mathematics, and engineering]. Our evidence is that more students move into sciences earlier than later, when curricula options are still available and mobility is not discouraged either by institutions, stringent curricular requirements, parents, or peers. At later stops in the educational pipeline, science attracts few newcomers and mainly battles to hold old adherents.[48]

There has been positive movement in the performance of minority students in scientific proficiency. ETS data indicate that from 1977 to 1986, 9- and 13-year-old black and Hispanic students showed gains on science proficiency while white students population evidenced only slight improvement.[49] For the 17-year-old population, a decline in science proficiency was recorded from 1977 to 1982 for black, whites, and Hispanic students. A reverse was noted for all

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[46] Gregg, Sandra. Paucity of Black Men Stymies Collegiate Environment. Black Issues in Higher Education, v. 5, Feb. 2, 1989. p. 2.

[47] Berryman, S. E. Who Will Do Science? Minority and Female Attainment of Science and Mathematics Degrees: Trends and Causes. New York: The Rockefeller Foundation, 1983. Ramist, L. and S. Aeioter. Profiles. College-Bound Seniors, 1985. New York College Entrance Examination Board, 1966. Thomas, Gail E. The Access and Success of Blacks and Hispanics in U.S. Graduate and Professional Education.

[48] Hilton, Thomas L. and Valerie E. Lee. Student Interest and Persistence in Science: Changes in the Educational Pipeline in the Last Decade. Journal of Higher Education, v. 59, Sept./Oct. 1988. p. 523.

[49] The Science Report Card: Elements of Risk and Recovery. Trends and Achievements Based on the 1986 National Assessment. Educational Testing Service. Report No: 17-S-01, Sept. 1988. p. 28.

subgroups from 1982 to 1986, with black students recording a significant increase. Because of the importance for blacks, black students actually surpassed their 1977 performance in 1986 while white and Hispanic students failed to equal such performance. While blacks and Hispanics narrowed their performance gaps, there remained disparity relative to white students. Data compiled for the report showed that the average science proficiency of 13- and 17-year old black and Hispanic students was approximately four years behind that of their white counterparts.[50]

There have been other gains in precollege preparation of minority students for science and engineering careers as evidenced by the average scores on the SAT. From 1978 to 1988, black students average combined scores (mathematics and science) on the SAT increased 51 points, from 686 to 737; Hispanic students average combined scores increased 29 points, from 755 to 784; Native American students combined scores increased 22 points, from 806 to 828, and white students combined average score during that same time period increased by 4 points, from 931 to 935.[51] While the statistical validity and reliability of the instruments continues to be been mired in controversy, average scores on the SAT have increased for virtually all minorities in the period 1978 to 1988 (both verbal and mathematics).[52]

In an ETS study of the "Persistence in Science of High-Ability Minority Students," it was found that when the requisite quantitative ability was maintained in high school, minority students persisted in science, math and engineering majors at a level equal to or higher than comparable nonminority students.[53] The cohort was from the population of students taking the SAT in 1984-1985 and also completing a 63-item questionnaire (Student Descriptive Questionnaire). The sample was limited to those students receiving a minimum of 550 on the math section, with no minimum SAT-verbal score. The discriminate function analysis employed by the study found that the minority students were high in science motivation, advanced in mathematics achievement, and relatively high in quantitative ability. Concurrent with these findings, it was concluded that these students were influenced more by their associations

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[50] Ibid., p. 29.

[51] Women and Minorities in Science and Engineering Education, p. 125. The score for the Hispanics resulted from combining the reported scores for Mexican Americans and Puerto Ricans.

[52] Crouse, James and Trusheim, Dale. The Case Against the SAT. Public Interest, Fall 1988. p. 97-110.

[53] The minority students defined by this study were black, Hispanic, and Native Americans. Hilton, Thomas L., Jayjia Hsia, Daniel G. Solorzano, and Nancy L. Benton. Persistence in Science Of High-Ability Minority Students. A Project supported by the National Science Foundation and the Educational Testing Service. Princeton, N.J., 1988. p. 163.

with other minority scientists (through summer jobs and part-time work) than by parents, teachers, or friends.

The ETS study was in agreement with assertions made previously by many in the academic and scientific community that minority students must be put in the pipeline at the earliest grades, and energy and resources must be provided to them in order to keep them there. The educational climate should be created that would focus not merely on the high-performing student, but on the bulk of the students who are the average and who can become the above-average. Expanded programs are needed at the precollege level targeted for the average students.

Many students are mercurial about their career plans in high school and even the beginning years of college. The transition period from elementary school to junior high school has been found to be a critical time for intervention aimed at preventing disillusionment and subsequent decline in the motivation of many minority students. Secondary school science should focus on providing minority students with the necessary skills and motivation to become qualified for science and mathematics majors in undergraduate school. Programs should be structured to correct high school deficiencies and gaps in the course prerequisites for entry into these fields. Both developmental components, coupled with effective tutoring would enable less well-prepared students to compete at a higher level in order to meet rigorous standards at the undergraduate level without special dispensation. Richard C. Richardson, Jr., associate director, National Center for Post-secondary Governance, cited fundamentals important to enabling minority students to earn degrees:

(1) Early intervention in the public schools to strengthen and improve students' educational planning;

(2) Summer "bridge" programs to accustom minority students to college-level course work and the campus atmosphere before they begin college;

(3) Special orientation programs and help with choice of courses and registration;

(4) Tailored financial-aid programs, including policies that recognize students may not be able to contribute as much in summer earnings to their aid packages if they participate in the bridge programs;

(5) Strong academic programs, coupled with courses designed to offset gaps in preparation;

(6) Adequate tutoring services, learning laboratories, and organized "mentoring programs;"

(7) Intrusive academic advising to guide selection of courses and to intervene before small problems become major; and

(8) Career guidance to translate nonspecific educational goals into programs of study where course work and desired outcomes are clearly linked.[54]

ENROLLMENT IN SCIENCE AND ENGINEERING BY MINORITY GROUPS: TRENDS BY GENDER AND ETHNICITY

The number of minorities in scientific careers is of course a direct function of the number of minorities obtaining an undergraduate or graduate degree in the sciences. While there has been an increase in the participation of minorities in the science and engineering disciplines at the undergraduate level, it is over such a small base that the significance is muted. A 1990 report of the National Academy of Sciences, ***On Time to the Doctorate: A Study of the Increased Time to Complete Doctorates in Science and Engineering***, found that, at the doctorate level, black and Hispanic students took more time to earn a doctorate degree than whites, and women were enrolled longer than men.[55] Differences were evident depending on discipline, yet blacks consistently took a longer time to earn their degree than any other group.

Blacks

While blacks are approximately 12 percent of the U.S. population, their numbers comprise a small percentage of the scientific and engineering personnel. Data from the Bureau of Labor Statistics indicate that in 1988, the 139,000 employed black scientists and engineers constituted 2.6 percent of all employed scientist and engineers, up from the previously recorded 1.8 percent in 1978.[56] In 1987, 6,359 (1.5 percent) of the 419,118 doctoral science and engineering workforce were black, an increase from the 2,709 (1 percent) in 1977.[57] A January 1990 report of the NSF found that blacks earned 5.1 percent of the bachelors degrees in science and engineering in 1987 (4.7 percent earned in 1985), and 3.4 percent of the science and engineering degrees at the master level in 1987 (down from 3.2 percent in 1985).[58] At the doctoral level, blacks earned 1.8 percent (266) of the science and engineering degrees in 1988, a slight

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[54] Richardson, Richard C., Jr. If Minority Students are to Succeed in Higher Education, Every Rung of the Educational Ladder Must be in Place. The Chronicle of Higher Education, v. 35, Jan. 11, 1989. p. A48.

[55] U.S. National Academy of Sciences. On Time to the Doctorate. A Study of the Increased Time to Complete Doctorates in Science and Engineering. Washington, 1990. 177 p.

[56] Women and Minorities in Science and Engineering, p. 28.

[57] U.S. National Science Foundation. Science and Engineering Personnel: A National Overview. Washington, 1990. Special Rept. NSF 90-310. p. 78.

[58] Women and Minorities in Science and Engineering, p. 144-145.

increase from the 1.7 percent earned in 1987.[59] In 1978, the percentage of science and engineering degrees earned by blacks at the doctoral level was 1.9 percent.

Hispanics

The diverse cultures of the Hispanic community have witnessed the fastest population growth of all minority groups. The education and social problems in this group are multiple. Four out of every 10 Hispanics, 16 to 24 years old, do not have a high school diploma; 50 percent of this population did not attend school beyond the ninth grade; and 33 percent never complete the seventh grade.[60] Approximately 40 percent of Hispanic children live in poverty.[61] These children, living at or below the poverty level, attend schools that provide inadequate education, and as a corollary, deficient instruction in science and mathematics. Hispanics students who do choose to pursue the sciences only recently have had networking provided to them with the expansion of the Hispanic Association of Colleges and Universities (HACU).[62]

Data on the participation of Hispanics in the scientific disciplines do not disaggregate this ethnic group, but rather treat them as a monolith. As a consequence, the data are limited because the underrepresentation varies among the groups (Mexican Americans and Puerto Ricans most often are relegated to lower socioeconomic groups and Cubans are most often found in the middle class). Presently, Hispanics comprise 9 percent of the U.S. population, yet represented less than 2 percent of all employed scientists and engineers.[63] In 1988, the approximately 96,000 Hispanic scientists and engineers represented only 1.8 percent of all scientists and engineers.[64] Hispanics earned 3.9 percent of the bachelors degrees in science and engineering in 1987 (versus 2.9 percent earned in 1985); 3 percent at the masters level (versus 2.4 percent earned in

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[59] Ibid., p. 149-150.

[60] Wiley, Ed, III. Education Dilemma Result of Tendency to Ignore Latino Family Problems. Black Issues in Higher Education, v. 7, Mar. 5, 1990. p. 6.

[61] Changing America: The New Face of Science and Engineering. Final Report, The Task Force on Women, Minorities, and the Handicapped in Science and Technology. Washington, Dec. 1989. p. 22.

[62] The HACU was formed in 1986 and now has a membership of 128 institutions. Any institution with at least a 25 percent Hispanic student population is eligible for membership. Thirty institutions have gained membership in the past year. Salazar, Guadalupe. Black, Hispanic Colleges Vow to Work Together. Black Issues in Higher Education, v. 7, Oct. 11, 1990. p. 1, 4.

[63] Ibid., p. 22.

[64] Women and Minorities in Science and Engineering, p. 32.

1985). Hispanic males earn slightly more bachelors degrees in science than Hispanic females. Of all science and engineering doctorate degree recipients in 1988, Hispanics earned 3.3 percent, a slight increase from the 3.2 percent registered in 1987.[65] Ten years earlier, in 1978, the percentage at the doctoral level was 2.5 percent.

Native Americans

There is a paucity of data on Native Americans in the educational system and, as a consequence, on their participation in the science and engineering disciplines.[66] Statistically, Native Americans have been either ignored or subsumed under "other" in national databases. Data that are available show that Native Americans have the highest dropout rate of all minorities, and are disproportionately placed in learning-disabled programs. Results from the 1980 census indicated that 7.9 percent of Native Americans, above the age of 25, had completed a four-year institution. Analogous to other ethnic groups, Native Americans have a multiplicity of educational and social problems. About 70 percent of native American families live below the poverty level.[67] Unemployment for urban Native Americans under the age of 22 has been recorded at 80 percent. The suicide rate for Native American youth is 280 percent higher than for U.S. youth in general.[68] By the age of 15.5 (10th grade), approximately 50 percent of Native Americans students do not attend high school. By the age of 18, more than 62 percent of this group's young adult population are not attending school.[69]

Native Americans are not a single entity, but rather constitute approximately 300 tribes in the continental U.S. and Alaska. Contrary to popular belief, less than 25 percent of this ethnic group live on reservations.[70] Presently, Native Americans total approximately 0.6 percent (1.4 million) of the U.S. population,

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[65] Ibid., p. 149-150.

[66] A 1990 report of the NSF states that data for Native Americans should be examined with some caution. As a result of the small sample size for Native Americans, the statistical reliability is considerably lower for this group than for other groups. Women and Minorities in Science and Engineering, p. 31.

[67] Locke, Patricia. American Indian and Alaska Native Education Issues. Prepared for the Rural Education Conference "The Rural Agenda of Educating All Children for the 1990s." May 12, 1989. New Approaches: Educating the Next Generation, June 26-28, 1989. p. 3.

[68] Ibid., p. 3.

[69] Ibid., p. 5.

[70] O'Brien, Eileen M. The Demise of Native American Education. Black Issues in Higher Education, v. 7, Mar. 15, 1990. p. 16.

and are 0.5 percent of all employed scientists and engineers.[71] A 1990 report of the NSF revealed that, at the bachelors level, Native Americans earned approximately 0.4 percent of the science and engineering degrees in 1987, a level they equaled in 1985; at the master's level, Native Americans earned 0.3 percent (an increase of 0.1 from 1985).[72] Native American women earned two-thirds as many bachelors degrees in the sciences as their male counterparts and approximately one-sixth as many bachelors degrees in engineering. Data for 1988 revealed that at the doctorate level, Native Americans earned a mere 0.2 percent (27 out of a total of 14,620) of the degrees in science and engineering, a proportion that nearly equaled that registered in 1987. In 1978, the proportion was 0.1 percent.[73] For degree attainment for all ethnic groups at the bachelors, masters, and doctoral levels, see figure 1 below.

Women

Presently, women constitute 45 percent of the U.S. workforce, yet comprise approximately 16 percent of all scientists and engineers.[74] The percentage of women engineers is significantly less than the percentage of scientists. Data for 1988 revealed that women comprised 4 percent of the engineering population and 30 percent of the scientific population.[75] An even smaller percentage of the women scientists and engineers are minorities. In 1986, approximately 5 percent of the female scientists and engineers were black, less than 1 percent were Native Americans, and 3 percent were Hispanic.[76] (See table 1 for degree attainment by women in science and engineering.)

Engineering Manpower Commission Report

The 1989 report of the Engineering Manpower Commission (EMC) of the American Association of Engineering Societies (AAES) reported that black student enrollment in engineering programs in 1988 increased 15 percent over the previous year, while total first-year enrollment for all students increased 3 percent (see table A1 in the appendix for total enrollment data; for total

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[71] Changing America: The New Face of Science and Engineering, Final Report, p. 24.

[72] Women and Minorities in Science and Engineering Education. p. 136-145, passim. Data for degrees earned in psychology and the social sciences were extracted prior to calculations.

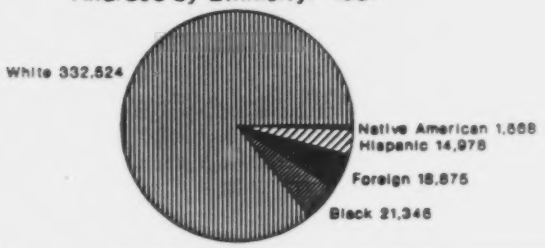
[73] Ibid., p. 149-150.

[74] Ibid., p. 3.

[75] Ibid.

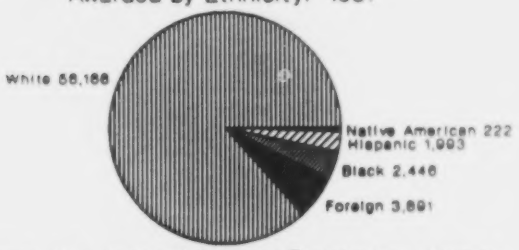
[76] Ibid.

FIGURE 1.
Science and Engineering Bachelor Degrees
Awarded by Ethnicity: 1987



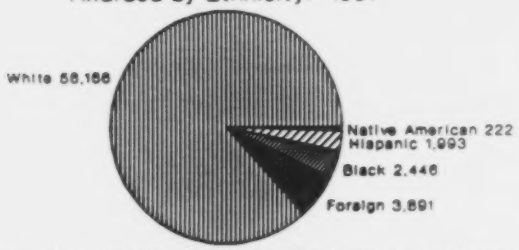
Source: U.S. National Science Foundation. Women and Minorities in Science and Engineering. Washington, D.C., Jan. 1990. p. 136, 137.

Science and Engineering Master Degrees
Awarded by Ethnicity: 1987



Source: U.S. National Science Foundation. Women and Minorities in Science and Engineering. Washington, D.C., Jan. 1990. p. 144, 145.

Science and Engineering Master Degrees
Awarded by Ethnicity: 1987



Source: U.S. National Science Foundation. Women and Minorities in Science and Engineering. Washington, D.C., Jan. 1990. p. 144, 145.

TABLE 1.
Degree Attainment by Women in Science and Engineering by Levels and Fields for Selected Years

Field	Bachelor's Degrees 1988		Master's Degrees 1986		Doctorates 1988	
	No. of Women	Percentage of Total	No. of Women	Percentage of Total	No. of Women	Percentage of Total
Total	123,057	38.0	19,182	30.7	5,382	26.6
Science, total	111,857	45.3	16,711	40.5	5,096	31.7
Physical	4,696	29.7	917	24.9	559	16.8
Mathematical	7,616	46.5	1,116	35.2	121	16.2
Computer	15,126	35.8	2,412	29.9	56	10.9
Environmental	1,354	22.3	517	23.1	144	19.8
Life	24,822	44.0	3,550	41.4	1,687	32.9
Psychology	28,246	69.0	5,426	64.9	1,675	54.8
Social	29,994	43.4	2,773	38.9	854	33.1
Engineering Total	11,203	14.5	2,471	11.6	286	6.8
Aeronautical/ Astronautical	248	8.5	43	6.9	9	6.0
Chemical	1,469	24.7	214	15.7	60	9.6
Civil	1,146	13.1	300	10.2	25	5.1
Electrical	2,856	12.0	556	10.0	38	4.3
Industrial	1,281	30.1	279	16.9	19	15.0
Mechanical	1,677	10.3	237	7.7	26	4.3
Other	2,526	16.8	842	13.7	109	8.4

SOURCE: U.S. National Science Foundation. Women and Minorities in Science and Engineering. Washington, Jan. 1990. p. 20, 22.

engineering degrees awarded, see table A2 in the appendix). This participation eversed the recorded decline of the previous five years.[77]

Data compiled by the EMC show also that engineering enrollment for women increased at every level from fall 1987 to fall 1988 (bachelors, masters and doctoral level). The increase in freshmen enrollment for women (from 1987-1988) exceeded that of freshmen as a whole, increasing from 15.7 percent to 16.2 percent[78] Enrollments for women at the masters and doctorate levels increased a percent point, to 13.9 percent and 10.7 percent respectively.[79]

For all the ethnic groups tracked by the EMC, blacks, Hispanics, Pacific Islanders, and Native Americans witnessed a significant increase in enrollments for fall 1988.[80] The increases were sharp enough to register growth in total full-time undergraduate enrollment for these minorities, except for Hispanics (Hispanic enrollment dropped by 0.6 percent).[81] Enrollment increases for blacks were found to be the most salient.[82] Engineering enrollments for blacks increased also at the masters level and at the doctoral level. Increased enrollments were recorded for Hispanics and American Indians (Hispanic enrollment did not increase at the masters level). However, total freshmen

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[77] Data from the Institute of Electrical and Electronics Engineers reveal that approximately 90 percent of students enrolled in engineering programs have a family member employed in a mathematics or science discipline or a mathematics- and science- related profession.

[78] Engineering Manpower Bulletin. Engineering Enrollment Highlights: Fall 1988, no. 95, May 1989. p. 2.

[79] Ibid.

[80] *It is possible that EMC's statistics could exaggerate the gains experienced by these minority groups. [EMC] studies count total numbers of students of each type-first year, all master's candidates, etc.-but do not explicitly identify the number of those students who are new. To the extent that students remain in a given group for more than one year, some may be counted twice. Furthermore, stress by EMC on obtaining complete data may have led to improved counts and better reporting.* Engineering Enrollment Highlights: Fall 1988. p. 3.

[81] Ibid.

[82] These increases occur at various schools throughout the United States, at both historically black colleges--Prairie View University, Howard University, Tuskegee University, and those institutions with a significant number of black engineering students, such as City college of New York, Georgia Tech, the University of Texas, Austin, and California State, Long Beach. Engineering Enrollment Highlights: Fall 1988. p. 2.

enrollment in engineering programs is expected to decline again in the fall of 1990, primarily because of the declining pool of potential college students.[83]

PARTICIPATION OF MINORITIES IN HIGHER EDUCATION

Factors Affecting Minority Participation

While the quantitative aspects of the disproportionate participation of minorities and women in higher education have been well documented, the variables which underlie that problem have not been sufficiently understood and/or analyzed, resulting in a data gap affecting the development and implementation of intervention strategies designed to increase the minority higher education pool, and subsequently, the science and engineering pool. Donald Stewart, president of the College Board, has asserted that: "The idea that a child who is simply smart or able or hard working will somehow get accepted to and complete college is a myth. Race, economic background, and financial ability now stand between a student and a college degree."[84]

Richard Richardson, of Arizona State's National Center for Postsecondary Governance and Finance, has posited that higher education is seeking to attract three varying levels of minority students. Richardson describes them as being:

(1) Well prepared students from middle class families, the most highly recruited group in the country today. "Schools and colleges need do little more to guarantee the success of these students;"

(2) The classic, first-generation college students, with low-income, upwardly aspiring parents, likely to have attended relatively segregated public schools and to lack acquaintances who know about college. "Colleges must intervene early to reinforce their aspirations and to guide their curriculum so that science and math are not neglected;" and

(3) Students from segregated communities and schools, negative and unsure of themselves in high school, who have not perceived college as a way of gaining status. . . . The same services and activities that are successful with athlete recruits will serve these

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[83] There was a temporary increase in births during 1969 and 1970, resulting in an increased number of potential college students now. After 1970, the trend of declining births continued, decreasing more than 15 percent in a three year period. Engineering Manpower Bulletin. Engineering Enrollment Highlights: Fall 1988, no. 5, May 1989. p. 1.

[84] Education That Works: An Action Plan for the Education of Minorities. Quality Education for Minorities Project. Massachusetts Institute of Technology. Cambridge, MA., Jan. 1990. p. 40.

> students. Our failure to serve them as well as we serve athletes is a failure of will and not of understanding or knowledge.[85]

However, often, colleges and universities aggressively compete for the academic superstars while ignoring the average students with modest credentials who are very capable of rigorous academic work.

The absence of minorities in higher education is significant. A report prepared by the American Association of Colleges for Teacher Education reported that 33 States have elementary and secondary minority enrollments of approximately 24 percent, while only six States have a higher education institution with minority enrollment greater than 15 percent.[86] The Department of Education 1988 college enrollment data (the latest year for which figures are available) reveal that blacks were 8.7 percent of the total (two- and four-year institutions) college population (a 10 percent increase from 1986), Hispanics were 5.2 percent (a 10 percent increase from 1986), and Native Americans were less than one percent, 0.7 percent (a 3.3 percent increase from 1986). (A disaggregation of enrollment by ethnicity and type of institution is contained in figure 2 below). For black students in particular, the increased enrollment was attributed to the increased attendance of women. From 1986 to 1988, enrollment of black men increased 1.6 percent, while enrollment of black women increased 6.3 percent.[87] While these minority groups have witnessed increased enrollment, they continue to lag far behind that of whites relative to their percentage of the total population (white students were 78.8 percent of the total college population).[88] Additional data indicate that approximately 10 percent of the students in the average college of education are minorities. However, in some institutions, minority representation is only about 1 percent or 2 percent.[89]

While many minorities enter the educational pipeline, the pipeline, constricts at various places along the way. In general, minority students attrition rate in higher education is greater than that for white students, and they are more

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[85] Forum. The Holmes Group, Fall 1988, v. 3. p. 24.

[86] American Association of Colleges for Teacher Education. Teacher Education Pipeline: Schools, Colleges and Departments of Education Enrollments by Race and Ethnicity. Washington, 1988. p. 33-34 and 41-42.

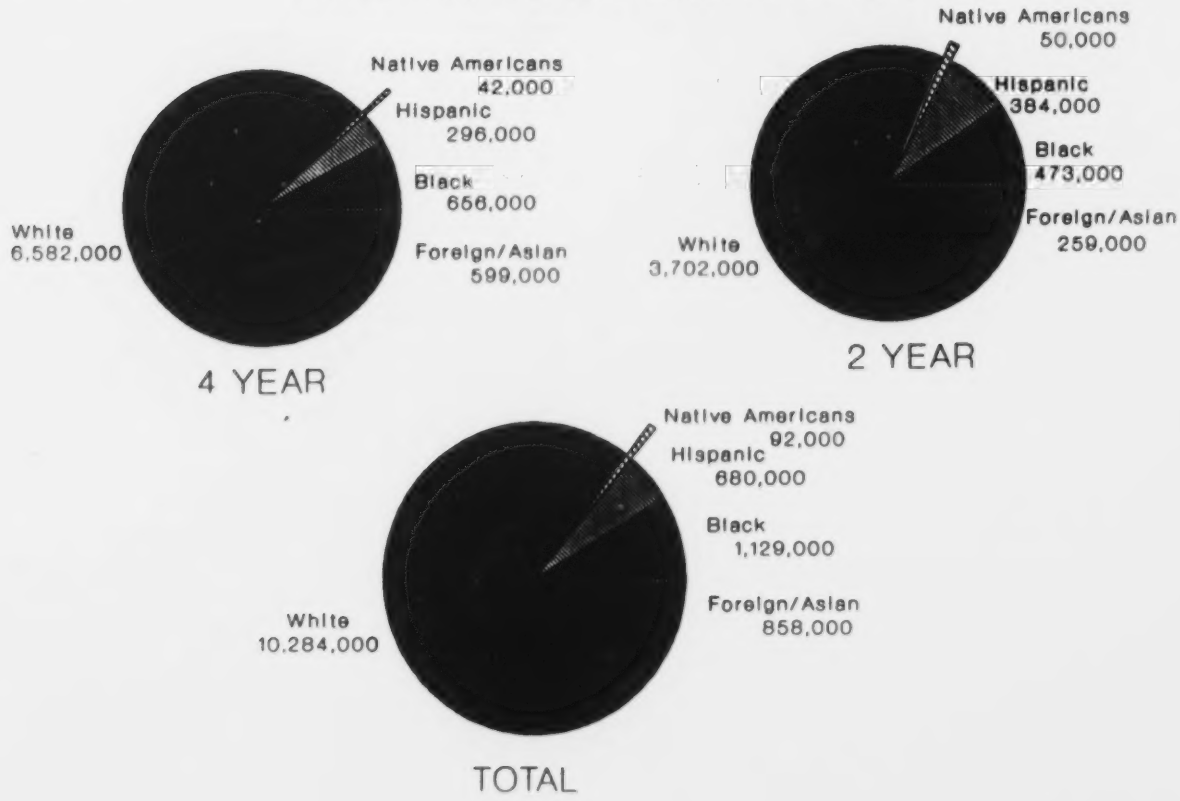
[87] Ibid., p. A37.

[88] U.S. Dept. of Education. Office of Educational Research and Improvement. National Center for Education Statistics. Trends in Racial/Ethnic Enrollment in Higher Education: Fall 1978 through Fall 1988. NCES 90-370. p. 3.

[89] Ibid.

FIGURE 2.

1988 COLLEGE ENROLLMENT BY ETHNICITY AND TYPES OF INSTITUTION



SOURCE: Evangetauf, Jean. 1988 Enrollment of All Racial Group Hit Record Level. The Chronicle of Higher Education, v. 35, Apr. 11, 1990. p. A 36.

likely to leave the educational pipeline altogether.[90] For those freshmen minority students declaring science as a major, an estimated 40 percent "leak" from the science and engineering pipeline by the end of their sophomore year in college.[91] In addition, fewer students "leak" into the science pipeline once they began their undergraduate education. The net loss is a concern not only to science, but also to higher education.

Some institutions of higher education have employed screening mechanisms (competency/skill testing) from all entering students. The emergence of these programs requiring skill testing has been extremely controversial and believed to hurt minorities disproportionately. For example, the Texas Academic Skills Program which all entering freshmen and transferring students in the State's public colleges and universities are required to pass prior to entering upper level courses, is said to impact negatively on minorities, specifically blacks and Hispanics.[92] It has been estimated that, though 50 percent of the students who take it will fail sections of the exam, it will eventually serve to improve retention rates and over all level of sophistication of the students in the university system.[93] While officials charge that the program is designed to improve retention rates, some educators maintain that because of deficiencies in some minority students' educational backgrounds, they will fail at a significantly higher rate.[94] The task force that constructed the test projected that the failure rate would indeed be higher for minorities than nonminorities. It was estimated that 72 percent of the blacks and 59 percent of the Hispanics would fail the reading section; 74 percent of the blacks and 63 percent of the Hispanics would fail the mathematics section; and 59 percent of the blacks and 27 percent of the Hispanics would fail the writing section.[95] Students who fail the test initially, would be required to take non-credit remedial courses and retake the test until they pass it. However, one of the many countercharges by

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[90] Persistence data are sometimes spurious in that many minority students do not necessarily drop out, but "stop out" for a period of time and sometimes even enroll at other institutions.

[91] Hilton, Thomas L., Jayjia Hsia, Daniel G. Solorzano, and Nancy L. Benton. Persistence in Science of High-Ability Minority Students. A project sponsored by the National Science Foundation Grant No. MDR-8652096 and the Educational Testing Service. Dec. 1988. p. 175.

[92] Mangan, Katherine S. Debate Intensifies Over Skills Test for Entering Students in Texas: Critics Call It a Barrier to Minority Groups. The Chronicle of Higher Education, v. 35, Mar. 8, 1989. p. A19, A20.

[93] Ibid.

[94] Texas is one of approximately 12 States requiring standardized testing for entry into public colleges and universities.

[95] Ibid., p. A20.

black and Hispanic officials is that remedial courses to be offered to the students who fail would not be available because of budgetary constraints.

Science in higher education attempts to approximate meritocracy in which all individuals enjoy equal rights and opportunities. However, disparity exists in the university science community between minorities and nonminorities. Minority science students are not always provided with mentors, and, consequently, are not provided with equal exposure in describing their scientific work at conferences.[96] Also for minority scientists, there is not equal access to graduate education, receipt of scholarships, promotion to higher ranks, receipt of research funds, access to outstanding research collaborators, and coauthorship of papers and other outlets for scientific publications. Data compiled by the NSF reveal that the underrepresented minorities receive a fraction of university support in U.S. graduate schools. Of the total 8,181 doctorate recipients in 1988 receiving support (teaching assistantships, research assistantships, fellowships, and other), blacks received 2.2 percent of the support, Hispanics received 2.8 percent, and Native Americans received approximately 0.1 percent.[97] This level of support is in sharp contrast to that received by Asians and whites, 25.1 percent and 66.8 percent respectively.[98] (See figure 3 below.) The differences and pattern of support have been continued over the years. Howard G. Adam, executive director, National Consortium for Graduate Degrees for Minorities in Engineering, Inc., has stated that:

> If . . . minority students have to rely almost exclusively on financial support from sources external to the university, this places them peripherally in department activities that leave the added burden of finding an advisor, research topic, supportive colleagues, and faculty mentors to guide the Ph.D. dissertation. Minus the critical experiences that one gains through departmental associations, far too many minority students terminate their graduate studies as ABD's (all but the dissertation completed), a status that many minority students attribute to their inability to identify an acceptable dissertation topic and/or a mentor to guide their research activities.
>
> This is a bothersome phenomena and one that demands immediate attention of academic leaders charged with equitable distribution of graduate study financial aid. . . . It is essential that all universities move to stop short-changing U.S. minority students and provide the financial and mentoring vehicles

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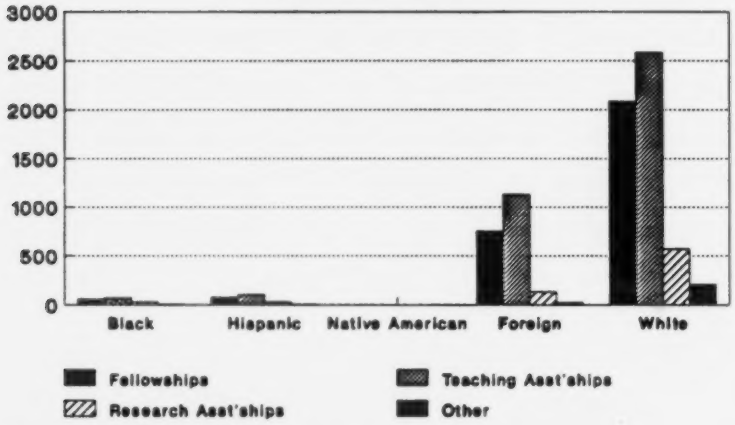
[96] Widnall, Sheila E. AAAS Presidential; Lecture: Voices From the Pipeline. Science, v. 241, Sept. 30, 1988. p. 1744.

[97] Women and Minorities in Science and Engineering, p. 157-159.

[98] Ibid.

FIGURE 3.

Total 1988 Science and Engineering Doctorates Receiving Support from the University by Type and Ethnicity



Source: U.S. National Science Foundation. Women and Minorities in Science and Engineering. Washington, DC. Jan. 1990. p. 136-159, passim.

necessary to assist this group in acquiring doctoral training. The nation's success in meeting the technological challenges of the twenty-first century depends on this.[99]

Women continue to be circumscribed in their admission to certain programs in higher education.[100] One problem limiting the number of women acceptable for enrollment in engineering school is the reliance on the SAT, adopted by many engineering schools in the early 1980s.[101] The College Board reports that approximately 23 percent of men and less than 11 percent of

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[99] Adams, Howard G. Minority Students Short-Changed. Black Issues in Higher Education, v. 5, Feb. 2, 1989. p. 25.

[100] Pearson, Carol S., Donna L. Shavlik, and Judith G. Touchton. Educating the Majority: Women Challenge Tradition in Higher Education. American Council on Education. New York, 1989. p. 294-306.

[101] Scientific, Engineering, Technical Manpower Comments. Commission on Professionals in Science and Technology, v. 25. Dec. 1988. p. 18.

women score 600 or higher on the SAT mathematics portion.[102] While the Committee on Ability Testing has questioned using SAT scores as a single criterion, many engineering departments have continued to require relatively high SAT mathematics scores for entrance. Also, collegial relationships (mentors) are critical to professional development in engineering.[103] In addition to having a predominantly white male faculty, a significant number of the teaching assistants in engineering schools are from cultures that place women in a subservient role and fail to value the quality of the women entering the discipline.[104]

While the propensity has been to examine the cultural backgrounds of minority groups in their participation in higher education, less attention has been focused on the economic or structural factors.[105] Economics has and continues to be the most pervasive modifying factor in the minority community. Prohibitive costs, funding uncertainties, and questionable benefits have discouraged many minorities from entering undergraduate and graduate programs and continued economic and personal constraints prevent many minority students from graduating after gaining entrance.[106] When a minority student has to weigh the seemingly enormous amount of time and money to pursue a college education, she/he sometimes opts for the burgeoning number of proprietary schools that will provide a certificate within a year.

The financial situation of minority students has been compounded by the limited number of student grants-in-aid made available by Federal and State governments. During the 1960s and 1970s, Federal, State, and private funding were provided to insure equal educational opportunities for minorities and women. Policies existed to expand educational opportunities for these groups

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[102] Ibid.

[103] Ibid.

[104] U.S. National Academy of Sciences. Committee on the International Exchange and Movement of Engineers. Office of Scientific and Engineering Personnel. Foreign and Foreign-Born Engineers in the United States: Infusing Talent, Raising Issues. Washington, 1988. p. 4.

[105] Tracey, T. and W. Sedlacek. The Relationship of Noncognitive Variables to Academic Success: A Longitudinal Comparison by Race. Journal of College Student Personnel, v. 38. p. 405-410.

[106] Between 1980 and 1987, the average tuition and room and board at private colleges and universities increased 43 percent; public colleges and universities costs increased 27 percent. During that same time period, median income for families with children 6 to 17 years of age increase 3.1 percent. Council on Competitiveness. Snap Shot. Human Resources. Washington, Aug. 1990. p. 2.

at virtually all levels of the educational system.[107] However, a change from grants-in-aid to loans for students, especially minority students, has discouraged some from the prospects of acquiring more debt. A study conducted by Alexander W. Astin, researcher, University of California, Los Angeles, ***The Black Undergraduate: Current Status and Trends in the Characteristics of Freshmen*** found that the proportion of black students receiving Pell Grants declined from approximately 55 percent in 1978 to 41.1 percent in 1989, while the proportion of black students receiving Stafford loans increased from 10 percent to approximately 28 percent.[108] In addition, some States, faced with budget constraints, have curtailed their support for equity in higher education while, simultaneously, the U.S. Department of Education's Office for Civil Rights has diminished its oversight of equity issues in higher education.[109]

Since fiscal year 1980, Federal aid for students in selected programs has decreased. Between fiscal year 1980 and fiscal year 1990 (and adjusting for inflation) funding for the Supplemental Education Opportunity Grant program has declined by 19.1 percent; Perkins loan funding has declined by 66 percent; work study support has declined by 28.6 percent; and TRIO programs for the disadvantaged (upward bound, talent search, and special support programs) have declined by approximately 9.2 percent.[110] However, other programs have increased. Since fiscal year 1980, Pell Grants have increased by 28.5 percent and Guaranteed Student Loans have increased by 48.8 percent (again adjusted for inflation).[111]

The policy of a shift to loans as a primary method of student support will have a disproportionate negative impact on minorities and women. The replacement of grants for education by student loans has caused many minority students to engage in self-screening out of an undergraduate education when

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[107] Mortenson, Thomas G. The Impact of Increased Loan Utilization Among Low Family Income Students. The American College Testing Program. Student Financial Aid Research Report Series 90-1, Feb 1990. p. 1-9.

[108] Astin, Alexander W. Higher Education Research Institute. University of California, Los Angeles, Graduate School of Education. The Black Undergraduate: Current Status and Trends in the Characteristics of Freshmen. June 1990. p. 56.

[109] Jaschik, Scott. Faced With a Shortage of Funds, Office for Civil Rights Has Cut Back on Many of Its Enforcement Activities. The Chronicle of Higher Education, v. 36, May 30, 1990. p. A17-A18.

[110] U.S. Library of Congress. Congressional Research Service. Higher Education: Reauthorization of the Higher Education Act, by Margot A. Schenet, Coordinator. CRS Issue Brief No. IB90028, July 20, 1990. p. 11. [continuously updated]

[111] Ibid.

they face assuming loans that exceed their family incomes.[112] Approximately 38 percent of entering black students are from families with annual incomes below $20,000 compared with 12 percent for their white counterparts.[113] Loans to be assumed by these students could range from $20,000 to $30,000 for graduate school, and, in the case of medical schools, $80,000 to $90,000. Upon graduation, many minority students opt for high paying jobs, rather than those such as teaching.

Presently, the Administration's FY1991 budget proposal would cut aid for approximately 300,000 students in 1991-1992. The decline in the number of students eligible for financial assistance would include the programs of State Student Incentive Grants, Perkins Student Loans, and the College Work-Study Awards. The decrease in funding for the Guaranteed Student Loan Program has been proposed at $730 million. The proposed budget would eliminate a $59 million Federal contribution to the Federal/State partnership which has provided grants to more than 197,000 students each year.[114] The proposed budget also would eliminate the Federal contribution of $135 million to the Perkins Student Loan program.[115] In addition, approximately 5,000 students would lose College Work-Study awards. These decreases in support as proposed in the FY1991 budget would hurt those students and families most in need of financial aid. The budget does, however, propose a 11.6 percent increase for the TRIO programs and a 71.8 percent increase for a relatively small program that provides awards to minority students. The drop in financial aid at colleges and universities could impact more on minorities and the poor, denying them a chance at higher education.[116]

An argument has been that the financial needs evaluation required by Federal and State authorities, designed to assess the financial circumstances of the majority, typically assumes a nuclear family structure. These guidelines exclude

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[112] Approximately 38 percent of entering black students are from families with annual incomes below $20,000 compared with 12 percent for their white counterparts. Astin, Alexander W. The Black Undergraduate: Current Status and Trends in the Characteristics of Freshmen. p. 38.

[113] Astin, p. 38.

[114] Many States provide more funding for this program than is required to match the Federal contribution. If Federal funds were to be cut, it is likely that aid would continue to be available to many of the currently reported students.

[115] DeLoughry, Thomas J. Bush's Budget Would Slash Aid to 300,000 Students in 1991-1992. The Chronicle of Higher Education, v. 36, Feb. 7, 1990. p. A29.

[116] Wilson, Reginald and Justiz Manuel. Minorities in Higher Education: Confronting a Time Bomb. Educational Record, v. 68, Fall 1987-Winter 1988. p. 13-14.

many minority students, especially blacks and Hispanics, and only strengthens class disparity.

While there has been a decrease in the percentage of black males enrolled in institutions of higher education, there has been a corresponding increase in the percentage of black males enlisting in the armed services.[117] Current research has found that the armed services have been able to attract the highly skilled, middle- to upper-income-level blacks who would have otherwise entered undergraduate school.[118] The military's increased pay and more generous GI Bill benefits may be more palatable than the repayment of a $20,000 student loan. Approximately 27 percent of Army enlistees are black, a percentage that is more than double their representation in the U.S. population as a whole.[119] In addition, approximately 42 percent of black males qualifying for entrance into the Army enlisted; comparative data for white males revealed that approximately 14 percent of those qualified actually enlisted.[120] William Cox and Catherine Tobe, writing in the Educational Record, put it succinctly when they stated that "It shouldn't be true that minorities bear a greater defense burden because they don't believe they will be treated as well in academia or industry as in the military."[121]

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[117] The percentage distribution of black males enrolled in institutions of higher education has also been described as leveling off. In 1978, 4 percent of the total enrollment institutions of higher education were black males; 3.8 percent of the total were recorded in 1980, 3.7 percent in 1982, 3.6 percent in 1984, 3.5 percent in 1986, and 3.4 percent in 1988. U.S. Dept. of Education. Trends in Racial/Ethnic Enrollment in Higher Education: Fall 1978 through Fall 1988. p. 4.

[118] Recent data indicate that the decline in college enrollment by blacks was primarily among middle- and upper-income blacks, not low income blacks as previously thought. Those black students in the middle to upper economic level are more than twice as likely to enlist in the armed services as opposed to black students living in the lowest income areas. Additional data reveal that in 1987, 44 percent of black males in the armed services were from areas with the lowest incomes for blacks, while 55 percent of the white males in the services were from the lowest incomes areas for whites. Wiley, Ed III. Advocates Call for Strategy to Stem Military Brain Drain of Blacks. Black Issues in Higher Education, v. 7, Apr. 26, 1990. p. 20.

[119] Wiley, Ed III. Advocates Call for Strategy to Stem Military Brain Drain of Blacks. Black Issues in Higher Education, v. 7, Apr. 26, 1990. p. 16.

[120] Moskos, Andrew. Black Exceptionalism: Making It In The Military. Black Issues in Higher Education, v. 7, Apr. 26, 1990. p. 76.

[121] Cox, William E. and Tobe, Catherine. Recruiting Wars: Can Higher Education Compete with the Military? Educational Record, Fall 1987-Winter 1988. p. 66.

Shortage of Minority Faculty and Administrators

There is a national shortage of minority faculty and administrators in higher education. A March 1990 report of the Department of Education found that, across all institutions (public and private, two-year and four-year), blacks comprised approximately 3 percent of the full-time faculty positions and 3 percent of the part-time faculty positions; Hispanics were 2 percent of faculty positions at both full-time and part–time faculty positions; and Native Americans were 1 percent of the faculty positions for both full-time and part-time.[122] The participation of whites accounted for 89 percent of full-time faculty and 90 percent of part-time faculty at all institutions.[123] Women accounted for 27 percent of full-time faculty across all institutions, yet 44 percent of part-time faculty.

The report revealed considerable variation in department program areas for minorities. Data for full-time faculty show that, in fall 1987, blacks comprised 1 percent of the engineering faculty, Hispanics, 1 percent, and whites, 83 percent (no faculty were recorded for Native Americans).[124] In the natural sciences, blacks were again 1 percent of the faculty, Hispanics were 2 percent, and Native Americans were 1 percent, while whites were 89 percent. In the health sciences, blacks were recorded at 3 percent, Hispanics at 1 percent, and Native Americans at 1 percent, while whites were 88 percent.[125] Women were 3 percent of the full-time faculty in engineering departments, and 15 percent of the faculty in the natural sciences. In contrast, women were 38 percent of the full-time faculty in education.[126]

The part-time faculty percentage distribution yielded slightly different results. In the natural sciences, blacks comprised 1 percent of the part-time faculty, Hispanics were 1 percent, and Native Americans 1 percent, while whites were 89 percent.[127] In the health sciences, blacks recorded their highest percentage distribution, 13 percent; Hispanics were 4 percent (this was the highest for this group tying with the humanities); Native Americans were 1 percent, while

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[122] U.S. Dept. of Education. Office of Educational Research and Improvement. National Center for Education Statistics. Faculty in Higher Education Institutions, 1988. NCES 90-365, Mar. 1990. p. 5.

[123] Ibid.

[124] Ibid., p. 11.

[125] Ibid. The largest percentage distribution for blacks was in education, at 7 percent, the largest for Hispanics was in the humanities, at 4 percent, and the largest for Native Americans was in agriculture and home economics, recorded at 2 percent (agriculture and home economics were also the largest for whites).

[126] Ibid., p. 6.

[127] Ibid., p. 12.

whites recorded a 72 percent participation. For expanded data on the participation of minorities and women in higher education see tables A3, A4, and A5 in the appendix.[128]

Minority faculty serve as role models and provide academic advising and student-faculty interaction that contribute to retention of many minority students. The declining participation of minorities, especially blacks, Hispanics, and Native Americans, in higher education could translate into further declines in black college enrollments and graduation rates, and exacerbate the current minority faculty shortage.

Historically Black Colleges and Universities

The historically black colleges and universities (HBCUs), which have traditionally educated a significant number of the Nation's blacks, have had the perennial problem of attempting to enhance their academic and research capabilities and developing programs to compete with other institutions of higher education in science and technology (see table A6 in the appendix for enrollment data in HBCUs).[129] These black institutions have a plethora of problems--inadequate support for student aid, deteriorating physical infrastructure, obsolete equipment, low salary structures, and limited funds for faculty development and new academic programs for students. While these problems exist in other institutions, they are chronic and magnified in HBCUs.

The HBCUs have not shared in distribution of Federal obligations to colleges and universities. Although funding to HBCUs has increased in the past 10 years in absolute terms, it decreased as a proportion of the total awarded to all U.S. colleges and universities. The NSF report, ***Federal Support to Universities, Colleges and Selected Nonprofit Institutions: Fiscal Year 1988***, indicates that HBCUs received only 8.1 percent of Federal research and development support to institutions of higher education in fiscal year 1988, down from 8.6 percent in fiscal year 1987 and 8.8 percent in fiscal year 1986. (A high of 9.8 percent was recorded in fiscal year 1983. See table A7 in the appendix.)[130] Additional support has been provided to HBCUs by Federal departments and agencies in the amount of $45.3 million for training, $37.4

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[128] Ibid. The highest percentage distribution of Native American was in the social sciences, recorded at 14 percent.

[129] Data compiled in 1988 revealed that undergraduate programs at historically black colleges and universities (HBCUs) had graduated approximately 75 percent of all black doctorates, approximately 75 percent of all black army officers, more than 80 percent of all black Federal judges, and 85 percent of all black medical doctors. Jordan, Vernon E., Jr. Blacks and Higher Education-Some Reflections. Daedalus, v. 117, Summer 1988. p. 281.

[130] U.S. National Science Foundation. Federal Support to Universities, Colleges, and Selected Nonprofit Institutions: Fiscal Year 1988. Detailed Statistical Tables, NSF 89-325. Washington, 1989. p. 23, 77.

million for facilities and equipment, $28.3 million for fellowships and recruitment under the Intergovernmental Personnel Act, and $245.8 million for student tuition assistance, scholarships, and other aid.[131]

Amid criticism by officials and representatives of HBCUs concerning the stark disparity in their receipt of Federal support, the Bush Administration has proposed a plan to marshal support for these institutions. The program would:

1. Strengthen an executive order, originally signed by President Reagan, directing Federal agencies to award more grant and contract money to black institutions;

2. Create the President's Board of Advisors on Historically Black Colleges and Universities;

3. Work with businesses to encourage support of black colleges;

4. Develop a new program that will allow more students at black colleges to serve in part-time and summer jobs in the Federal Government; and

5. Provide $10 million for a competitive program to help increase the endowment of black colleges.[132]

Black colleges also have not been able to achieve parity in private endowments. Only recently have philanthropic organizations begun to increase their support for minority education, after withdrawing in the mid-1970s. Their private efforts have increased simultaneously with the programmatic retreat by Federal and State Governments. However, philanthropic support to minority institutions is limited and the shortcomings are magnified for those students in attendance who are economically disadvantaged. The Council for Aid to Education reported that in 1987-1988, private contributions to U.S. colleges and universities totalled $8.2 billion. During that same time period, private support to black institutions totalled $56.2 million ($46.2 million to the United Negro

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[131] U.S. Dept. of Education. Fiscal Year 1988 Annual Federal Performance Report on Executive Agency Actions to Assist Historically Black Colleges and Universities. Prepared by The White House Initiative on Historically Black Colleges and Universities in accordance with Executive Order 12320. Washington, 1989. p. 17-28, passim.

[132] Wilson, Robin. Black-College Officials Applaud Bush Plan, but Some Say It Ignores Most-Pressing Issues. The Chronicle of Higher Education, v. 35, May 10, 1989. p. A1, A23.

College Fund (UNCF) and $10 million to public black institutions), less than one percent (0.7 percent) of the private support to all U.S. institutions.[133]

Recent support was provided to selected minority institutions by Walter H. Annenberg, former Ambassador to Great Britain, who gave $50 million to the UNCF. However, the majority of the HBCUs do not receive funding from the UNCF.[134] There are approximately 104 HBCUs, yet only 41 of the private institutions have membership in the UNCF and will gain directly from this contribution.[135] Additional gifts, such as the $20 million given to Spelman College by William and Camille Cosby, are needed to increase endowments and contribute to annual operating budgets not only of UNCF institutions, but all HBCUs.

There have been other in the Federal funding of colleges and institutions. Only recently have HBCUs imbalances been listed with any frequency among those institutions receiving congressionally "earmarked" funds.[136]

Betty M. Vetter, Executive Director of the Commission on Professionals in Science and Technology, has acknowledged that some of the most successful programs designed to attract underrepresented minorities into the sciences have been initiated at HBCUs. Supporting data from the National Research Council indicate that a significant number of these students graduating from bachelor and masters programs at HBCUs further their studies in doctoral programs at predominantly white universities. Reginald Wilson, former director of the American Council on Education's Office of Minority Concerns, stated that this preparation of minority scientists is: ". . . [A] tribute to the black colleges'

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[133] Sudarkasa, Niara. All 117 Black Colleges and Universities Require Dramatic New Levels of Philantrophic Support. The Chronicle of Higher Education, v. 36, Mar. 28, 1990. p. B2.

[134] A condition of the gift requires matching funds.

[135] The UNCF was established in 1944 to raise funds for private black colleges. As a consequence, public institutions are not eligible for membership in the UNCF. In addition, the UNCF excludes those private institutions established after 1954. This date is used as a terminal date for "historically" black institutions because it was synonymous with the Supreme Court's landmark decision in *Brown v. Board of Education* which ended legal segregation in public schools. The rational for the exclusion was that public black institutions would receive the necessary support from State governments. However, these public black institutions are state-assisted and not state-supported and must still obtain 30 percent to 60 percent of their funding from non-State sources.

[136] Cordes, Colleen. Congress Earmarks $270 Million for Specific Projects at Universities. The Chronicle of Higher Education, v. 36, May 9, 1990. p. A28-A30.

unique capacity to instill confidence in students, and to their special dedication to nurturing talent through methods like mentoring."[137]

Major Research Universities

Promoting pluralism is a major challenge for higher education, and specifically major research universities. While both the black and Hispanic populations undergo exponential growth, the rate of black and Hispanic enrollment and retention in major research institutions in all disciplines continues to lag far behind that of their white counterparts. A confluence of admission policies, academic offerings, funding practices, and the racial composition of the faculty and administration at major research institutions all perpetuate a stigma of "less than" (i.e., inferior) for some minority students. Solomon Arbeiter, Associate Director of Research and Development at the College Board, states that: ". . . [A]s the white teenage pool declines into the early 1990s, institutional survival will dictate that the outreach for minorities and other nontraditional students grow stronger."[138] Experts agree that not only must these institutions recruit minorities and women into their science and engineering programs, they must also develop retention programs to ensure that the students complete their degree. The absence of minority academic advisors and minority role models at predominantly white institutions contributes to the high attrition of minority students, many of whom are basically underprepared. A supportive climate and academic tutoring (when needed) have ensured high retention and graduation rates among blacks and Hispanics.[139] In addition, research has shown that a positive correlation exists between a high degree of student involvement and retention; as a result, emphasis should be place on interactions that maximize the chances for student involvement.[140] However, the existing tenure and promotion systems at most universities do not reward

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[137] Wycliff, Don. Blacks Advance Slow in Science Career. New York Times, June 8, 1990. p. A14.

[138] Arbeiter, Solomon. Black Enrollments: The Case of the Missing Students. Change, v. 19, May/June 1987. p. 19.

[139] Clewell, B. C., M. E. Thrope, and B. T. Anderson. Intervention Programs in Math, Science, and Computer Science for Minority and Female Students in Grades Four Through Eight. Educational Testing Service. Princeton, N.J., 1987, Clewell B.C. Intervention Programs: Three Case Studies. (Blacks, Science and American Education, edited by Pearson, Willie, Jr. and H. Kenneth Bechtel. Rutgers, The State University, 1989. p. 105-122, and Carmichael, J. W., Jacqueline T. Hunter, Deidre D. Labat, John P. Sevenair, and Joanne Bauer, Sr. An Educational Pathway into Biology-and Chemistry-Based Careers for Black Americans. Journal of College Science Teaching, v. 17, Mar./Apr. 1988. p. 370-371.

[140] Minorities On Campus: A Handbook for Enhancing Diversity. American Council on Education ed., Madeleine F. Green. Washington, 1989. p. 29-54, and 113-130.

professors to be involved in mentorship programs, especially for minorities, in a substantive way.

Another issue is the racial climate in major research universities. A Massachusetts Institute of Technology (MIT) survey conducted in the fall of 1985 found that many of the black alumni interviewed reported that their professors had had low expectations for them and that prejudicial attitudes abounded, not only by faculty, but also by the students. In the release of this survey, ***The Racial Climate on the MIT Campus***, Paul Gray, former MIT President, Paul Gray, acknowledged that the report carried a distressing message in that minority students would encounter a myriad of problems.[141] A recent report of the California Postsecondary Education Commission (CPEC) ***Toward An Understanding of Campus Climate*** found similar charges of alienation and overt and subtle racism and discrimination by minority students.[142] The report resulted from interviews with approximately 480 students and faculty and staff at eight universities and community colleges in the California system. Penny Edgert, Specialist with the CPEC, observed that:

> Institutions are still oriented to serve, in the main, white male students. . . . You are going to find students of color and women--particularly in math and science-based programs--consistently and permanently, irrespective of campus, feel alienated, feel that the campus doesn't work for them. No matter what campus you are on, it always feels that way.[143]

Jacqueline Fleming, adjunct professor, Barnard College, found that in various studies of minority students in predominantly white institutions, high achieving white students received more attention from faculty members than high achieving black students.[144] Marie L. Johnson, Assistant Professor of Education, and W. Clarke Douglas, Assistant Professor of History, University of Illinois argued that:

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[141] Dean, Shirley M. McBay. The Racial Climate on the MIT Campus. A Report of the Minority Student Issues Group. Massachusetts Institute of Technology. Office of the Dean of Student Affairs, Sept. 1986. 22 p.

[142] California Postsecondary Education Commission. Toward an Understanding of Campus Climate. A Report to the Legislature in Response to Assembly Bill 4071 (Chapter 690, Statues of 19898). Commission Report 90-19. June 1990. 69 p.

[143] Tachibana, Judy. Campus Climate Often Hostile to Women, Minorities, Report Shows. Black Issues in Higher Education, v. 7, Aug. 16, 1990. p. 6-7.

[144] For Teachers of Minority Students. Factors Stimulate Success for Black Colleges, Spring 1989. p. 2.

> Faculty treat students more favorably and obtain better performance when their expectations are positive. What is sometimes noted but not always conceded at the university level is that expectations of students who are "different" from the instructor tend to be more negative and often lead to differential treatment which in turn reduces the likelihood of "success." When this "special treatment" is based on racial stereotypes about minorities' ability to learn and perform, it is especially damaging.[145]

Richard Richardson charges that some research universities are "inhospitable environments" for students who are not the best-prepared or highly motivated. There are some minority students who are unable to deal with their marginal status, cultural isolation and the impersonality endemic to all students. He states that:

> Most universities will not, however, be able to achieve proportional participation by concentrating on well-prepared minority students. There are simply not enough to go around. They will need to admit minority students who are less well-prepared on several criteria than their majority colleagues. To insure that the access provided by differential admissions standards does not result in diminished quality, teaching strategies must accommodate its strengths and weaknesses of more diversely prepared students.[146]

In yet another examination of minority students on predominantly white campuses, the American Council on Education reported that:

> More frequently, the problems are subtle. Minority students often feel marginal, conspicuous, and isolated from the mainstream of the institution. The scarcity of minority students, faculty and administrators is perceived as institutional indifference to minority issues. The absence of a minority focus in the curriculum is interpreted as a devaluation of diversity. These environmental problems may compound any academic difficulties experienced by minority students. Thus, minority

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[145] Johnson, Marie, L., and Douglas, W. Clarke. The Classroom Experience: The Missing Link in Minority Retention Efforts. Black Issues in Higher Education, v. 5, Feb. 2, 1989. p. 24.

[146] Richardson, Richard C., Jr., p. A48.

> students often find it doubly difficult to feel comfortable in the campus majority culture.[147]

Some universities have improved their retention rates of moderately prepared minorities by steering them to such disciplines as ethnic studies, and other liberal-arts majors that do not require significant science and mathematics programs. Richardson states that such institutions are ". . . guilty of academic fraud if they do not provide the assessment, academic support, and learning strategies necessary to encourage minority achievement in mainstream, high academic fields."[148]

Liberal Arts Colleges

A March 1987 report, ***Maintaining America's Scientific Productivity: The Necessity of the Liberal Arts Colleges***, focused on the "science active" liberal arts colleges and universities and their ability to conduct basic scientific research.[149] The report was a result of a study conducted by Oberlin College in which 50 science active liberal arts colleges were identified as conducting effective, meaningful, basic research in the absence of doctoral level departments. The report also observed that these liberal arts colleges appeared to be doing a better job of addressing the needs of historically underrepresented groups in the sciences--women and minorities--than major research universities. Approximately 15.2 percent of the women enrolled at these particular colleges majored in the sciences, as compared to 11.1 percent at the top 20 research universities.[150] Preliminary data indicated that 39.8 percent of the minority students enrolled at these liberal arts colleges choose science as a major, the proportion for non-minority students was 28.1 percent.[151] While the report cited the need for additional data and analysis of trends in patterns of freshmen minority enrollment, but it was quite evident that these institutions were attracting a larger proportion of minority students than non-minority students to major in the sciences. The liberal arts institutions have been shown to compete with leading institutions, and to exceed some of them both in the quality of science graduates (as measured by career distinction), and in their quantity (as a proportion of all graduates).

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[147] Minorities on Campus: A handbook for Enhancing Diversity. American Council of Education edited by Madeleine F. Green. Washington, 1989. p. 114.

[148] Richardson, Richard C., Jr., p. A48.

[149] Carrier, Sam C. and David Davis-Van Atta. Maintaining America's Scientific Productivity: The Necessity of the Liberal Arts Colleges. A report of the second conference on "The Future of Science at Liberal Arts Colleges," held at Oberlin College. Oberlin, Ohio, Mar. 1987. 140 p.

[150] Ibid., p. 16.

[151] Ibid., p. 18.

Community Colleges

A significant number of minority students who attend college, enroll at two-year (community colleges) rather than four-year institutions, primarily because of financial limitations. These community colleges have been very instrumental in enabling minority students to make the transition from secondary school to institutions of higher education.[152] Department of Education 1988 data indicate that approximately 41.9 percent of black students, 56.5 percent of Hispanics, and 54.3 percent of Native Americans attended two-year institutions.[153] In comparison, 36 percent of white students attended these same institutions during 1988.

Community colleges unquestionably provide entrance opportunities for the minority population, but after access, their continuation in higher education is less certain. While many minority community college students articulate a desire to transfer to a bachelor's program at a four-year institution, in actuality, they enter an undergraduate program at a proportionately lower rate than nonminority students. Data indicate that while 75 percent of community college students indicate a desire to transfer to four-year institutions to continue their education, only 15 percent to 25 percent actually transfer.[154] Many of these students terminate their education when they find they are unable to transfer earned credits to a four-year institution, and in those infrequent cases when transfer is possible, the process is found to be cumbersome. James C. Palmer, Associate Director of the Center for Community College Education at George Mason University, has described the transfer process as a "tough bureaucratic task."[155] He further stated that:

> Community college students can go buckety-buck through their courses thinking they will all transfer to a four-year institution, and maybe they do. But what these students may not know is that the courses are accepted for elective credit, not for credit toward the major. . . . In some cases this student will . . . take

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[152] U.S. National Science Foundation. Report on the National Science Foundation Workshop on Science, Engineering, and Mathematics Education in Two-Year Colleges. Division of Undergraduate Science, Engineering, and Mathematics Education. Two-Year College Workshop, Robert E. Parilla, Chairman. Washington, Oct. 31-Nov. 1, 1988. 12 p.

[153] Evangelauf, Jean. 1988 Enrollment of All Races Hit Record Level. p. A36.

[154] Watkins, Beverly T. Two-Year Institutions Under Pressure to Ease Transfers. The Chronicle of Higher Education, v. 36, Feb. 7, 1990. p. A37.

[155] Ibid.

> more courses in upper division. In other cases, the student will get discouraged and drop out.[166]

In a recently released report of the California Postsecondary Education Commission on community college transfers, it was found that while emphasis had been placed on increasing the transfer rate for students from community colleges to four-year institutions, few black and Hispanic students actually transferred.[167] Instead, the transfer programs and transfer centers established by the California system had served to only further increase the number of students who traditionally had recorded significant transfer rates--whites and Hispanics.

Administrators at community colleges charge that officials at four-year institutions are not responsive to improving the complex transfer of students from community colleges. Martin Haberman, Professor of Education at the University of Wisconsin, Milwaukee, like many other educators, suggests that community colleges form a cooperative recruitment program between two- and four-year institutions to enable students to transfer with more facility. Agreements have been reached between community and four-year institutions in approximately 30 States to make the transfer process less obscure and more palpable, but they are not always effective and they represent only a fraction of institutions. The sheer number of students who begin their higher education at community colleges is indicative of the need to expand and reform the transfer process.

PROGRAMS AND STRATEGIES FOR MINORITY STUDENT ENRICHMENT

Considerable efforts have been made to address the problem of the underrepresented minorities in science, mathematics, and engineering, through mentoring programs, curriculum development programs, university-industry alliances, and effective partnerships between predominantly minority institutions and departments of science and engineering at major research universities. Many of the programs and alliances by the various sectors--Federal, State, university, and private sector--provide effective intervention strategies. Following is a discussion of such programs and strategies. There has been no attempt to make this an exhaustive or definitive compilation, but merely to illustrate the various efforts to address the cumulative effects of minority underrepresentation.

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[166] Ibid.

[167] Tachibana, Judy. Minority Two-Year Transfer Rates Not Making the Grade in California. Black Issues in Higher Education, v. 7, Aug. 30, 1990. p. 18-19.

Federal Involvement

The NSF has established Comprehensive Regional Centers for Minorities (CRCMs) in California, Florida, Missouri, Pennsylvania, and Texas, to provide support for minorities students enrolled in science programs from kindergarten through the undergraduate program. The CRCMs are located at the California State University, Los Angeles; Florida A&M University; University of Missouri, St. Louis; Philadelphia Alliance for Teaching Humanities: Philadelphia Renaissance in Science and Mathematics (PATHS/PRISM); and the University of Texas, El Paso. These centers are in addition to the three established in 1988 in Atlanta, New York City, and Puerto Rico. Combined, the existing centers are located in States and areas that encompass approximately 40 percent of the black student population and 70 percent of the Nation's Hispanic student population.[168]

The NSF proposes to establish an additional 7 centers which would eventually address the needs of more than half of all minority students in the United States. Grants for this program have been designed to foster alliances among colleges and universities, local and State governments, and community groups. The efforts from this alliance are intended to develop a systematic method for addressing the national problem of underrepresentation of minorities in the scientific and technology disciplines. The progress of the Centers will be monitored by the NSF in order to identify activities that are most successful for possible duplication. Annual assessments will determine level of funding for subsequent years.

The NSF, as part of their Institutional Infrastructure Program, has awarded $50,000 each to 6 HBCUs in an effort to promote increased participation of women and minorities in science and engineering education. The initial funding will be targeted for developing five-year plans to upgrade computer facilities, increase technical research, and improve computer science curricula.

In 1989, the NSF initiated a three-year cooperative program, designed to ". . . impart the skills of a nationally-known master teacher to others in his field."[169] The program, named the Jaime Escalante Math and Science Program, will enroll certified teachers of mathematics, physics, chemistry, computer science, and English, and approximately 400 junior and senior high

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[168] U.S. National Science Foundation News. NSF Creates Centers to Promote Local Efforts for Future Minority Scientists and Engineers. NSF 89-65. Sept. 15, 1989. p. 2.

[169] U.S. National Science Foundation. National Science Foundation News. Jaime Escalante Receives NSF Award, NSF-PR-89-45. p. 1.

students.[160] Escalante, along with other master teachers, will apply techniques Escalante developed in his successful Advanced Placement Program in Calculus, to other science subjects. Based in East Los Angeles, a low-income area comprised chiefly of Hispanics, the program is aimed at attracting urban and other disadvantaged youth to careers in science, mathematics, and engineering. The approximately $1.5 million project will receive $457,033 from the NSF, $150,000 from Arco Foundation, and $900,720 from the Los Angeles Community College System.[161]

The U.S. Department of Energy has funded a university consortium, composed of 15 institutions, to focus on the training of minority students for careers in the environmental sciences. Membership is composed of both HBCUs and other colleges and universities with a significant minority population. The Department of Energy has provided $250,000 for undergraduate fellowships in the related fields of toxic-waste management and environmental restoration.

The NSF has awarded North Carolina A&T State University a grant of $2.5 million to increase the number of black doctorates in communications related technology disciplines. For more than a decade, U. S. institutions have graduated an average of five blacks with doctorates in electrical engineering and computer science. For whites, approximately 400 a year have graduated in the same disciplines. North Carolina A&T hopes to graduate four students each year who will enter doctoral programs at the four participating universities--Duke, Stanford, Michigan, and Michigan State.[162]

In July 1989, the National Aeronautics and Space Administration (NASA) announced the establishment of the Strategic Preparedness Advancing Careers in Engineering (SPACE) Scholars Program at Morehouse College. NASA will provide $6.5 million over a period of eight years to the historically black institution to increase the number the students, especially black males, pursuing doctoral degrees and teaching and researching in the fields of chemistry, mathematics, physics, engineering, and computer sciences. An analogous program is operating at Spellman College.[163] Students will take science

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[160] Jaime Escalante received national recognition for his work in preparing his high school students to take advanced calculus standard tests. In addition to having been given the title of Master Teacher in the California educational system, he also received the Medallion of Excellence from the congressional Hispanic Caucus, and Presidential recognition from George Bush as being an "American hero" for his work in grass-roots education.

[161] Ibid., p. 3.

[162] Presently, North Carolina A&T does not have a doctoral program in computer science but does have joint doctoral degree programs with North Carolina State University.

[163] NASA Gives Morehouse $6.5 Million to Establish Project SPACE Program. Black Issues in Higher Education, v. 6, Aug. 17, 1989. p. 12.

courses for three years at Morehouse and more rigorous courses at participating graduate institutions. The 20 students selected each year for the scholarships, on the basis of GPA, SAT/ACT scores, and intended majors, would also engage in research at one of the 10 NASA research centers. The scholarships would include tuition, room and board, books and supplies, and travel for summer research assignments.

NASA's Human Resource Services and the Society of Women Engineers have entered into an interorganizational program to interest more women in engineering. The main focus of the program is to identify, recruit, and retain larger numbers of women in engineering.

The Minority High School Student Research Apprentice Program (MHSSRAP), sponsored by the National Institutes of Health (NIH), Division of Research Resources, is designed to stimulate increased interest among minority high school students in the biomedical sciences and the health professions. Developed in 1980 by Frank Press, then Director of the Office of Science and Technology Policy, the program has expanded from 45 participating institutions to more than 320.[164] The institutions are awarded $1,500 per high school student to cover the cost of student salaries and enrichment programs.[165] Since its inception, the program has supported approximately 7,000 students.

A Minority Access to Research Careers and Minority Biomedical Research support program, sponsored by the NIH, has been established at Hunter College. The program trains minority undergraduates and master's level students for careers in the sciences. Outreach and recruitment of promising students interested in the sciences is conducted also.

State Involvement

Mathematics, Engineering, Science Achievement (MESA), a California-based program, provides both personal and academic support services to minority students, beginning in the seventh grade. MESA receives total funding of approximately $2 million annually from State, private sector, and philanthropic organizations. At the precollege level, MESA provides junior and senior high students the support and services (incentives for academic performance, tutoring and study groups, course placement and advising, summer enrichment programs) to ensure them success in undergraduate school. In 1987, MESA supported approximately 4,500 black, Hispanic, and Native American students from more than 170 junior and senior high schools.[166]

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[164] Weinstock, Cheryl P. Program Sparks Students' Interest in Science Careers. Research Resources Reporter, v. 7, Oct. 1988. p. 3.

[165] Ibid.

[166] Attracting More Minorities to the Sciences. Educational Record, v. 68/69. Fall 1987/Winter 1988. p. 52.

The Iowa General Assembly has approved a $1 million program to increase the participation of minority students and faculty members in their State colleges and universities. The legislation appropriates $550,000 for financial aid to minority students, $200,000 for recruiting minority faculty, and $300,000 for college-bound voucher programs. The voucher program allows junior and senior high students to earn vouchers by attending college activities and seminars. These vouchers are then submitted to a state institution when applying for financial aid. Preference is given to those students with vouchers.[167]

University-Sponsored Programs

Syracuse University's L. C. Smith College of Engineering received an endowment of $1 million from the Corning Glass Works Foundation to award scholarships to minority students.[168] Included in the endowment will be scholarships (partial tuition) for three engineering students each year (sophomore, junior, and senior levels), with the first students selected in the spring of 1990.

In 1978, Northwestern University's Technological Institute established a Minority Opportunities in Engineering Program. The program assigns incoming freshmen with a minority tutor and provides five weeks of orientation, including intensive classes in mathematics, chemistry, computer science, and writing and speaking skills. Counseling and tutorial services are provided to these students through their undergraduate program. The program has improved the retention rate for the students who have participated.

The Institute for Science, Space and Technology at Howard University, School of Engineering was established in 1987 to serve as a stimulus for increasing and expanding the academic participation and preparation of minority students in science, engineering, and technology. The Institute provides technical assistance to minority institutions and organizations for strengthening science and engineering programs, disseminates data and information for policymakers in developing and evaluating programs, and conducts local and national forums for leaders in science and technology to discuss current issues and opportunities. During the first year of its activities, the Institute accomplished the following:

1. Organized a national symposium on science, engineering, and technology issues for the Congressional Black Caucus;

2. Provided technical assistance and support for science and engineering faculty at HBCUs seeking scientific partnerships; and

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[167] Blumenstyk, Goldie. Iowa Starts $1-Million Plan for Minority Students. The Chronicle of Higher Education, May 24, 1989. p. A25.

[168] Scholarship Fund Established by Corning for Black Engineers. Black Issues in Higher Education, v. 6, June 8, 1989. p. 21.

3. Assisted school systems in developing linkages with colleges and universities to implement strategies and programs that strengthen minority interest and education in science and mathematics for careers in science and engineering education.[169]

The Institute has moved beyond these initial steps and has also:

4. Identified major and emerging research opportunities for minority scientists;

5. Explored employment, human resources and professional development;

6. Developed strategies and approaches for informing the minority community about the values of science, engineering, and technology; and

7. Assessed minority undergraduate and graduate science and engineering education.[170]

Xavier University's "Can Do Campaign" is targeted toward attracting and retaining more underrepresented minorities in science, mathematics, and engineering. This program provides intervention while the student is still in high school–improving problem solving skills and self confidence and motivation. The program stresses remedial courses, not watered down material.

The Center for Precollege Programs at the New Jersey Institute of Technology (NJIT) has developed a curriculum to interest and prepare minority students for careers in science, engineering and technical fields. The programs have served, also, to develop and improve the students' self-confidence and self-esteem about learning in general. Approximately 80 percent to 90 percent of the students participating in NJIT's summer programs are urban youth.[171] Follow up on the participants revealed that approximately 20 percent to 25 percent of the students matriculate at NJIT with nearly 70 percent electing science- and mathematics-based majors.

Programs of the American Indian Science and Engineering Society, (AISES) and the Native American engineering program at the University of Colorado and the University of Oklahoma have produced an increase in enrollment of Native

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[169] The Institute for Science, Space and Technology Newsletter. Howard University, School of Engineering. Fall, 1988. p. 2.

[170] Ibid.

[171] Kimmel, Howard, Nancy Martino, and Reginald Tomkins. An Approach to Increasing the Representation of Minorities in Engineering and Science. Engineering Education, Dec. 1988. p. 186.

American students in the discipline since 1982.[172] The efforts of these programs, alone, have contributed significantly to the participation of Native Americans in engineering.

Native American Engineering and Science Program (NAMES) at the New Mexico Institute of Mining and Technology, provides intensive summer programs for precollege students in science, mathematics, writing, and college survival skills.

Phillip Uri Treisman, Director of the Charles A. Dana Center for Innovation in Mathematics and Science, University of California, Berkeley, developed a program for minorities and women that stresses academic excellence rather than remediation.[173] It is considered an anti-remediation program because it focuses on strengths rather than weaknesses. The students are given work that is at a higher level, rather than at a lower level, than they receive in regular mathematics class, and are simultaneously urged to excel rather than to avoid failure. The program was initially designed for calculus, which is a prerequisite not only for science and engineering majors, but also for architecture, business, and other professional degrees.[174] Since the beginning of the program in 1978, the failure rate for calculus for the underrepresented groups has dropped form 60 percent to 4 percent, compared to a failure rate of 15 percent for the total freshmen class.[175] Data from fall 1988 indicate that of the 89 students participating in the intensive mathematics sections, only two failed. Of the 123 blacks and Hispanics who were not enrolled in the intensive sessions, 66 failed.

The Berkeley program has served a dual role for the students. In addition to improving their proficiency in mathematics, it has improved their general academic performance. In addition to improved grade point averages, the collaborative nature of the workshops has improved their communication skills.

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[172] Harris Tierrina, Kathryn and Paul Phillip Biemer. The Dance of Indian Higher Education: One Step Forward, Two Steps Back. Educational Record, Fall 1987/Winter 1988. p. 91.

[173] Remedial courses have the propensity to cause students to fall further behind, rather than bringing them to grade level because such courses often proceed at a slower pace than "mainstream" courses. Remedial classes may also result in isolation of minority students from the mainstream of campus life.

[174] This program has been replicated at other colleges and universities, and is most often referred to as the Emerging Scholars Program. In addition to mathematics, similar programs have been designed for physics, chemistry, and biology.

[175] Watkins, Beverly T. Many Campuses Now Challenging Minority Students to Excel in Math and Science. The Chronicle of Higher Education, v. 35, June 14, 1989. p. A16.

A special commission comprised of regional organization of colleges and universities in New York State is to help expand the pool of minority participation in higher education. This partnership between the institutions of higher education and the communities is seeking to increase minority participation on college campuses. The commission's purpose is to extend beyond just attracting more minority 12th graders into undergraduate school, to "attacking the broader problem of why the nationwide pool of such students is so small."[176] The plan has three basic components. The first is to focus on students in kindergarten through 6th grade. It will attempt to identify students "at risk" and to implement intervention strategies which include tutorial services, out-of-school enrichment programs and mentoring/role models. The second component is to provide similar services for students in grades 7 through 12. Services will not be relegated to science and mathematics, but will include all skill levels. The third component has as its locus to attract more minority students into teaching at all levels, precollege through graduate school. It will provide special scholarship assistance and research opportunities with college faculty and other specialists in a student's particular interest.

Activities of Corporations, Foundations, and Professional Societies

The Colonial Penn Group, Incorporated awarded an Apple computer to each of the 11 members of the academic excellence team at Robert Vaux Junior High School, Philadelphia, Pa. The members were all black male youths.[177]

The Clare Booth Luce Fund has a trust of $70 million to support the advancement of women in science and engineering.[178] The fund will provide $3.5 million a year for professorships, scholarships, and fellowships for women students and faculty. Sixty percent of the trust has been designated to 14 selective institutions, with the balance of the trust awarded to other institutions invited by the foundation to submit proposals.[179]

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[176] Commission of New York Colleges Develops Plan to Improve Minority Access. Black Issues in Higher Education, v. 5, Feb. 2, 1989. p. 26.

[177] Innovative Approach to Reaching Out to Black Youth. Black Issues in Higher Education, v. 6, Aug. 31, 1989. p. 32.

[178] McMillen, Liz. Clare Boothe Luce Fund to Spend $3.5 Million a Year to Encourage Women to Study and Teach Science. The Chronicle of Higher Education, v. 35, July 5, 1989. p. A23.

[179] The 14 institutions are Colby College, Mount Holyoke College, Mundelein College, Trinity College (Washington, D.C.), Boston, Creighton, Fordham, Georgetown, Marymount, Santa Clara, St. John's, Seton Hall University, the University of Notre Dame, and Villanova School in California.

The Bush Foundation provides $1 million annually to encourage women at the precollege level to pursue science as a career.[180]

The Eleanor Roosevelt Fund of the American Association of University Women Educational Foundation provides approximately 50 "sabbatical fellowships" annually to teachers at the precollege level to develop programs encouraging their female students to continue and expand their studies in science, mathematics, and technology.[181]

In August 1989, the Kellogg Foundation made a $225,000 grant to the Southern Education Foundation to assist HBCUs improve their science education curriculum and to increase the number of minority science teachers.[182] The funding supports a research network among six HBCUs and Columbia, Harvard, and Vanderbilt Universities.[183]

Linkages is a program of the American Association for the Advancement of Science (AAAS) in its Office of Opportunities in Science program designed to aid community organizations expand the pool of minorities, women, and the disabled in scientific and technical careers. Linkages works very closely with community organizations and provides initial funding (seed grants) for beginning programs or for expanding existing ones.

In 1980, the National Action Council for Minorities in Engineering (NACME) was formed to increase the pool of minorities with engineering degrees. NACME's success is due primarily to partnership among teachers, business people, groups serving minorities and science centers. The Incentives Program is one of many strategies employed by NACME to increase the number of minorities who earn bachelor degrees in engineering. The incentive program has provided approximately $13 million to more than 7,000 students to pursue degrees in the sciences.[184]

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[180] Ibid.

[181] Ibid.

[182] Producing More Black Science Teachers is Goal of New SEE Project. Southern Education Foundation News. v. 4, Jan. 1990. p. 2.

[183] Participating institutions include: Albany State College; Bethune-Cookman College; Grambling University; Harvard University Graduate School of Education; Johnson C. Smith University; Peabody College of Vanderbuilt University, Teachers College, Columbia University, Tuskegee University, and Xavier University.

[184] Association of Science-Technology Centers. Natural Partners: How Science Centers and Community Groups Can Team Up to Increase Science Literacy. Washington, July 1987. p. 7.

The National Urban League has been active in encouraging minorities to participate in science since the 1940s with its Tomorrow's Scientist Today. The program, since changed to Tomorrow's Scientists, Technicians and Managers (TSTM), provides extensive tutorial service, career counseling, and on-site visits to industrial and scientific institutions to observe professionals at work. All of the students enrolled in TSTM are strongly encouraged to select accelerated classes in mathematics, science, and English. Minority role models speak with the students about their educational backgrounds and career options. In addition to the TSTM program, the 113 affiliates of the Urban League have many programs to promote science and math literacy.[185]

In 1985, the Girls Clubs of America began Operation SMART (Science, Mathematics and Relevant Technology) to develop girls' interest in science and mathematics. The Girls Club formation of the programs resulted from the serious underrepresentation of women in the scientific and technical fields as a result of impediments faced early in childhood. In addition to providing support to the girls involved in SMART, the leaders have formed linkages with other groups promoting science education--the Boston Children's Museum, AAAS, and the Children's Television Workshop.

The Westinghouse Steering Committee for Minority Communications is composed of a corporate-wide group whose purpose is to develop communications and strengthen relationships between the corporation and the minority community throughout the United States. Central to the Committee is to appraise minority youth of career opportunities in science, engineering and technology. Since its beginnings in 1978, the various campaigns of the Committee have communicated opportunities to potentially 211 million people.[186] The company's black and Hispanic engineers and high technology professionals serve as credible role models for technical careers.

The American Indian in Science and Engineering Society (AISES) was formed in 1977 to increase the representation of Native Americans in science and engineering education and to provided a cadre of technically trained native Americans to work with and advise the tribal elders.[187] The programs of AISES are expansive, and include scholarship programs; precollege, undergraduate and graduate, and professional training and support components; and a comprehensive communications network among Native Americans tribes,

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[185] Ibid., p. 8.

[186] Springer, Cecile. M. Director. Contributions and Community Affairs. Westinghouse Electric Corporation. Pre-College Education of Minorities in Science and Engineering: Conference Proceedings. New Jersey Institute of Technology, Newark, N.J., May 22-25, 1988. p. 117.

[187] Ramsey, J. N. Educating American Indian Youth, as Supported by the American Indian Science and Engineering Society. PreCollege Education of Minorities in Science and Engineering: Conference Proceedings. New Jersey Institute of Technology, Newark, N.J., May 22-25, 1988. p. 137.

schools and universities, agencies and organizations, and educators, both Native American and non-native American. The organization has funded more than $200,000 in scholarships and has developed more than 45 chapters on college campuses.

The Center for the Advancement of Science, Engineering, and Technology (CASET), with support from the Department of Labor, NASA's Johnson Space Center, and with technical oversight from the Army Research Center for the Behavioral and Social Sciences, is researching the needs of the underrepresented minority groups in science, engineering, and technology (SET). The objectives of the research--"A Study to Determine and Test Factors Impacting on the Supply of Minority and Women Scientists, Engineers, and Technologists for Defense Industries and Installations"--are multifaceted, but have as its prime objectives to:

> (1) Design, develop, and pilot-test Intervention Modular Unit Packages (IMUPs) to enhance the recruitment, selection, performance, and retention of American Indians, blacks, Hispanics, and women, in SET careers with DOD and defense contractors;
>
> (2) Recommend policy options for the period 1990-2010 when serious shortages may appear, impacting on defense preparedness, national security, immigration, and international technological competitiveness;
>
> (3) Provided the knowledge base to improve recruitment and retention of American women and minorities for DOD civilian personnel, ROTC science/engineering programs, and uniformed Active, Reserve, and National Guard professionals and to provide new ways which defense contractors may intervene to increase the SET pool;
>
> (4) Establishment of a National database and network using a collaborative approach to share information and reinforce efforts to increase the pool of qualified, professional minority and female SETs.[188]

Preliminary data from this study indicate that middle class status has a positive effect for science and engineering careers, regardless of race or ethnicity. However, when class was not used as a control, approximately 60 percent of Asian American students elected and persisted in science and mathematics as

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[188] Internal Document. Center for the Advancement of Science, Engineering, and Technology of Houston-Tillotson College. NASA, Johnson Space Center. A Study to Determine and Test Factors Impacting on the Supply of Minority and Women Scientists, Engineers, and Technologists for Defense Industries and Installations.

opposed to less than 2 percent of the underrepresented minorities. Additional analysis revealed that approximately 50 percent of black and Hispanic youth with mathematics SAT scores of 550 and above, who declared science, engineering or math as a major, changed their discipline prior to their junior year in college. The study will attempt to identify intervention methods that have a positive effect on the cultural, economic, educational, career, and personal factors while simultaneously being cost-effective. Of the approximately 300 interventions that have been identified to date, more than half have support mechanisms relating to factors other than financial or educational. The policy goal is to expand the science, engineering, and technology pool by including more of the underrepresented minorities.

The Reginald F. Lewis Foundation, donated $1 million to Howard University for scholarship aid to disadvantaged students. The gift from the foundation will be matched by a $1 million grant from the Federal Government. In addition to the donation to Howard University, the Lewis Foundation awarded $25,000 each to Virginia State University, Morgan State University, and Hampton University.[189]

Fairchild Industries and the Tektronix Corporation have established a SHARP (Summer High School Apprenticeship Research Program) program to provide expanded opportunities for minority students interested in science, electronics, engineering, computer science, and space technology. This program has created, also, scholarships for minority students to defray college expenses and reduce the reliance on student loan programs.

The General Electric Foundation has pledged $35 million to be used over a 10-year period to help increase the participation of women and minorities in university faculty and to help increase the number of minority inner-city students attending college. Approximately $15 million is to be expanded on faculty-development program to encourage minorities to pursue advanced degrees and to teach at the university level in areas such as science, engineering and business. The other program will be directed toward increasing the number of college-bound high school graduates from urban areas by providing them with Saturday programs, preparation classes for college entrance examinations, and training courses for teachers and parents to better assist these students in science, mathematics, and communication skills.[190] The foundation proposes to spend $1.5 million annually to finance full-tuition fellowships for 60 first-year doctoral students, renewable $5,000 loans for second-year doctoral candidates that will be forgiven if the students enter teaching, and three-year, $60,000 grants to assist young faculty members in their research.

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[189] Howard University Receives $1 Million. Black Issues in Higher Education, v. 5, Feb. 2, 1989. p. 32.

[190] Fuchsberg, Gilbert. General Electric Pledges $35-Million for Minority Effort. The Chronicle of Higher Education, v. 35, Dec. 7, 1988. p. A27.

The Amoco Foundation will make grants totaling $2 million over the next six years to help improve science and mathematics programs at seven historically black colleges and universities (HBCUs) and to help attract more students to these institutions. Also included in this grant is an award of approximately $425,000 to the Atlantic University Center, Inc., to administer Amoco's Historically Black Science Advancement Program.[191]

The Florida Endowment Fund in Higher Education is a public-private partnership providing scholarships to increase the number of blacks in higher education. The fund awards scholarships up to $5,000 for tuition and a $10,000 stipend each year for a period of three years of doctoral study at one of 11 participating Florida institutions.[192] The majority of the awards have been in disciplines where blacks have historically been underrepresented--science, engineering, and mathematics. Unlike many other programs, those receiving these awards are not indentured to the system following completion of their program. This program and other similar ones (National Consortium for Graduate Degrees for Minorities in Engineering and the Committee on Institutional Cooperation Fellowship Program) provide minorities the opportunity to increase their presence in academia by increasing access for blacks to all levels of higher education. It is expected that, by the year 2000, approximately 33 percent of the Nation's current faculty in colleges and universities will retire.[193]

The Andrew W. Mellon Foundation has awarded a total of $2.6 million to the United Negro College Fund to establish programs targeted at increasing the number of minority faculty in the arts and sciences.[194] The programs will support 20 fellowships every year for a period of three years to undergraduate students attending colleges and universities participating in the UNCF. For those students electing to continue through graduate school, stipends will be provided and a portion of their undergraduate loans will be forgiven. The program also will provide fellowships each year for a three year period to minority faculty members at member institutions of the UNCF and the American Indian College Fund. Each fellow will receive $24,000 for research or dissertation completion, which will in turn help to strengthen the member institutions arts and science programs.

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[191] Hartley, Charles J. Amoco Foundation: $2 Million to Black Colleges. The Chronicle of Higher Education, v. 35, Dec. 7, 1988. p. A27.

[192] Collison, Michele N-K. Public-Private Alliance in Florida Provides Scholarships to Enable More Blacks to Seek Doctoral Degrees. The Chronicle of Higher Education, July 29, 1988. p. A27.

[193] Ibid.

[194] McMillen, Liz. Mellon Foundation Gives United Negro College Fund $2.6 Million to Recruit New Faculty Members. The Chronicle of Higher Education, v. 36, Jan. 17, 1990. p. A31-A32.

The American Geological Institute's Minority Participation Program sponsors scholarships for geoscience majors who are members of the underrepresented groups in the geosciences--blacks, Hispanics, and Native Americans. Since its beginning in 1970, the program has awarded more than $500,000 to geoscience majors (geology, geophysics, geochemistry, hydrology, meteorology, oceanography, planetary geology, and earth science education). Awards range from $500 to $2,000. In the 1988-1989 school year, 35 scholarships were awarded, totaling $28,750. While the AGI does not offer scholarships to address underrepresentation of women, specifically, approximately 30-40 percent of the recipients of these awards in recent years have gone to women.

The Charles Stewart Mott Foundation awarded $6 million to eight HBCUs for capital improvements, faculty-development programs, and financial aid to students.[195] The Mott Foundation has provided a total of $20 million to these institutions over the past 10 years.[196]

Rockwell International's Science Center has formulated and promoted innovative programs in higher education to increase representation of minorities in the scientific and engineering professionals.

Exxon Research and Engineering Company has created an alliance with five New Jersey high schools. Exxon donates laboratory equipment to the schools in exchange for the names of those minority students gifted in science and mathematics. These students are selected to work in Exxon's laboratories during the summer, paired with a researcher, and permitted to work on a research project. The cost of Exxon's summer program exceeds $50,000.

Dow Chemical's "Touch Tech" program is expansive. Approximately 40,000 precollege students visit its museum chemistry laboratory annually. In addition, the company provides yearly workshops for more than 60 classroom teachers to work with researchers and devise improved methods for teaching science to children.[197] In addition, Dow Chemical has a Touch Tech Mentors Program with a predominantly black high school. Each summer, Dow admits 10 to 15 of the highest achieving students from this school to its laboratories, and provides them with a salary, mentor, food, lodging, and a summer job in research.

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[195] The participating colleges are Benedict College, Bennett College, Dillard University, Johnson C. Smith University, Morehouse College, Spelman College, Tuskegee University, and Xavier University.

[196] Bailey, Anne Lowrey. Mott Foundation: $6 Million for 8 Black Colleges, v. 34, July 20, 1988. p. A29.

[197] Katauskas, Ted. Industry Cultivates Minorities. R&D Magazine, Feb. 1990. p. 69.

POLICY ISSUES

The discrepancy between minority participation in science, mathematics, and engineering and overall minority population trends is one of the most critical issues currently confronting the educational system. Previous challenges in education have been met with the establishment of land-grant colleges, the G.I. Bill, the Vocational Education Act, the National Defense Education Act, and the Elementary and Secondary Education Act. The Task Force on Women, Minorities, and the Handicapped in Science and Technology proposed that the issue of underrepresented minorities in the sciences be addressed with the same fervor that was accorded science education following the launch of Sputnik in 1957.

For the most part, past and current policies have been inefficient and ineffective in recognizing and attempting to address the problems of minority students in science, mathematics, and engineering as evidenced by enrollment and graduation data. The role of the NSF might be heightened by making its efforts more congruent with those of the National needs. The NSF could assist minority precollege efforts by examining the process of science, engineering, and mathematics education in underrepresented groups. There is a paucity of information on understanding the problems of minority students at the precollege level. Available minority data collection at the precollege level often does not distinguish between blacks and Hispanics or between Puerto Ricans or Chicanos. Not all the education problems of the underrepresented groups are parallel, nor are they the same in rural areas or urban areas. The NSF would not be in the position to solve the problems, but could support research that might help to define them. In addition, reliable data concerning precollege science and mathematics course-taking are nonexistent for minorities and non-minorities. As a result, it is difficult for practitioners and policy makers to focus on problems and discontinuities in the underrepresented groups. The NSF could initiate a regular data collection effort which utilizes the resources of the National Center for Education Statistics, and various national ethnic organizations to compile an accurate picture of the participation of minorities in science, engineering, and mathematics.

Many of the information-sharing programs of the NSF are reactive rather than proactive, stimulating information flow within an area or locality, but not between the NSF and its constituents. Primarily at the precollege level, there is a great need that the results of operational and meritorious projects reach others quickly and in a manner which gets the information directly to the practitioner. The NSF should provide national leadership for minority science, engineering, and mathematics efforts by providing a national clearinghouse similar to the model of Educational Resources Information Center (ERIC). A national clearinghouse could provide a comprehensive national collection and distribution point for data, instructional materials, and methodologies for successful precollege models. In addition, the clearinghouse could establish a national register of corporations interested in interacting with school systems to improve science, engineering, and mathematics capabilities of all students. An expansion to the clearinghouse could not only receive information from

different consortia and Federal agencies but also disseminate the materials throughout the United States by means of an electronic bulletin board system.

The Department of Education's support of science and mathematics education has not approximated that of the NSF. The Department of Education supports science and mathematics mainly through Title II of the Elementary and Secondary Education Act, as amended by P.L. 100-297 (prior 377). Programs of the Department that contribute significantly to the science education efforts, with components targeting minorities and women, include those of the Dwight D. Eisenhower Mathematics and Science Education program and the Upward Bound Program. While there has been a 62.2 percent increase in the Department for programs directly affecting science and mathematics education in fiscal year 1991 from fiscal year 1990, it has been proposed that the efforts of the Department of Education be furthered increased and enhanced through collaboration with the NSF.[198] It is the opinion of agency officials that collaboration could stretch resources and extend the effectiveness of all involved. Successful collaboration with schools, school systems and states is a critical component to any efforts. Collaborative efforts proposed by the two agencies include:

(1) Establishment of stronger liaison between the two agencies, including joint public appearances and joint statements on appropriate matters by the Secretary of Education and the Director of the National Science Foundation;

(2) Closer and more stable working and funding arrangements;

(3) Joint programs with the States and programs targeted at urban education;

(4) Expansion and improvement of National Assessments of student achievements in the sciences and mathematics; and

(5) Increased dissemination of high quality projects sponsored by the National Science Foundation and expanded distribution by the Department of Education[199]

While the focus to address the needs of science education has been given mainly to the NSF, and to a lesser degree, to the Department of Education,

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[198] U.S. Congress. House. Committee on Science, Space, and Technology. Subcommittee on Science, Research and Technology. Precollege Science and Mathematics Education. Testimony of Erich Bloch, former director, National Science Foundation. p. 53-64. Testimony of Lauro Cavazos, Secretary of Education. p. 35-48. Hearings, 101st Cong., 2d Sess. Washington, U.S. Govt. Print. Off., 1990.

[199] Ibid., p. 59.

other Federal agencies could expand their efforts in addressing the needs of underrepresented minorities. (For a partial listing of the support by Federal agencies see table A8 in the appendix). The programs in the agencies have gone from a "few in number and small in scope" to a "flood of support."[200] However, few of the programs operating for a period of time have been analyzed or evaluated. In the absence of evaluation components or empirical data, it is not discernible if the programs warrant replication or how they should be restructured. Joseph Danek, Director of the Division of Research and Improvement, NSF, stated that: "We see so few minority scientists and engineers that whatever we've been doing isn't giving us the desired results."[201]

The Department of Energy (DOE) as a consumer and patron of a significant fraction of the Nation's scientists, mathematicians, and engineers, has had a long tradition of support for and involvement in science education. Primarily through its network of national laboratories and research facilities, DOE has expanded its role in the national effort to improve the science education system, including overall science literacy and the participation of minorities and women in the sciences. The efforts of the DOE are designed to complement those of the NSF, the Department of Education, State and local governments, and the education community as a whole. DOE is seeking to expand its efforts at the precollege level, to intervene during the early years of education before students, primarily minorities and women, foreclose their chances of entering the science and engineering pipeline. The effort of the DOE could serve as models for other agencies with limited involvement. DOE initiated 11 new partnerships in fiscal year 1991 to address the needs.

The Department of Defense (DOD) also is a consumer of scientists, mathematicians, and engineers. Presently, there are a number of education programs in DOD which are designed at attract, train, and advance a sufficient supply of fully qualified individuals in scientific and technical fields. Some of these programs are directed at minorities and women who are proportionally underrepresented in DOD's scientific and technical workforce. (For an expanded discussion of programs at the precollege, undergraduate and graduate levels, see CRS Report 89-256--***Science and Engineering Education: The Role of the Department of Defense***.[202] At issue is whether or not there is a further role for DOD in science and education. How should DOD mobilize the resources and professional participation required to affect science education significantly over a period of time? What programs should be implemented to broaden the pipeline of minority youth pursuing science, engineering and technology careers?

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[200] McIntosh, Hugh. New Series of Federal Programs Aims at Attracting Minorities. The Scientist, May 28, 1990. p. 10.

[201] Ibid.

[202] U.S. Library of Congress. Congressional Research Service. Science and Engineering Education: The Role of the Department of Defense. CRS Report 89-256 SPR, by Christine M. Matthews. Washington, Apr. 1989. 30 p.

At present, science education efforts in DOD are characterized by considerable delegation to the Services and agencies. Congress may wish to consider, in its fiscal year 1991 authorization bill for DOD, including language to require the Undersecretary of Defense for Acquisition to put the Director of Defense, Research, and Engineering (DDR&E) in charge of all DOD science and engineering education programs (precollege, undergraduate, and graduate). One individual could be delegated with full authority for these programs and could take a proactive role in facilitating interservice coordination. Having the responsibility of science education programs placed with one individual might might help to prevent duplication of efforts while simultaneously guarding against inadequacy of funding in any particular area. A centralized point of unified leadership and authority for science programs in the DDR&E could be expected to foster improved coordination with the Services and DOD components by strengthening and maintaining intervention methods and placing less of a burden on any one agency's constrained resources. In addition, increased systematic coordination may permit the Services and the DOD components to establish complementary goals and objectives for science and engineering education at all levels. Equally important, during the DOD authorization process, one person would be able to present to Congress a DOD-wide integrated picture of its various science education activities. On the other hand, the current system's multiplicity of inputs from the various services and agencies has certain advantages, such as allowing a wide range of expertise in program design so as to represent the various interests involved.

A second action that could occur before implementing or expanding any intervention programs would be a comprehensive review of all current DOD science and engineering programs. The review could include: (1) the amount of funding by the Services and the DOD components for all science and engineering programs; (2) the goals and objectives of the programs; and (3) coordination mechanisms currently in use (including documentation and evaluation of existing mechanisms). The review could also determine possible mechanisms for optimum coordination of the various programs. Centralization and increased coordination of science education efforts could enable the DOD to place its current and newly initiated programs in the context of broader national concerns.

Coupled with the discussion of improving the participation of blacks, Hispanics, Native Americans, and women in the sciences is the discussion of improving the entire science education system for all students. It has been suggested by various Federal administrators of science and engineering programs, academicians, and precollege level officials that coordinated interagency efforts would serve to guarantee the most effective use of limited funding sources. Each agency could be cognizant of the others programs so that duplication of efforts could be avoided. Coordinated efforts are in evidenced by the formation of a committee convened by the Federal Coordinating Council for Science, Engineering and Technology. An additional intra-agency coordination science and technology group has been formed by the White House Initiative on Historically Black Colleges.

Collaboration is needed between colleges and universities and public school officials to design programs and curricula to expand the pool of minority students interested and able to qualify to enroll in the sciences. More colleges and universities should expand their policies by establishing partnerships with local schools, particularly urban schools that most often have the least resources. Public colleges and universities could be required to enroll and graduate minorities in proportion to their representation in the State population (or could at least approach representation). In addition, the States could provide financial assistance that factors in minority students' lower economic resources and the protracted period of time required for graduation.

In addition to recruiting more students to enlarge the pool of scientists, engineers, and mathematicians, efforts also should be directed at retaining student interest in science and engineering and thereby reducing the attrition from the talent pool. Research has found ways to create a more positive environment for encouraging and retaining minorities and women in science, mathematics, and engineering--the introduction of role models, use of intervention programs, familiarizing teachers with their subtle forms of discrimination and exclusion by ethnicity and gender, and creation of classrooms which foster high expectations and efficacity. No matter how successful precollege remediation strategies, early identification programs, and programs to ensure undergraduate recruitment, without retention of a significant number of students, a critical shortage of minority scientists, mathematicians, and engineers will continue for the foreseeable future.

The education of students is not the monopoly of the schools. The business community is a segment of the economy that depends on the effectiveness of the schools. Increased partnerships between business and education, between scientists and educators, between educational institutions at different levels, between state and local governments and business, and between the Federal Government and all the other sectors would help. There is an economic argument for public investment in education in general, and for science, engineering and mathematics in particular, when examining the country's productivity decline.

The needs are great and immediate; the problem of underrepresented minorities in the sciences requires multiple solutions applied systematically to guarantee that limited resources are used effectively. In a position paper prepared for the Congressional Black Caucus Symposium on Opportunities and Challenges for Minorities in Science and Technology, David Johnson, Executive Director, Federation of Behavioral, Psychological and Cognitive Sciences, wrote that:

> More of everything is needed: more Federal attention to erasing inequity, more effort to negate the obstacles to academic achievement that often accompany a childhood spent in poverty, more intimate involvement of parents in the education of their children, more community participation in reinforcement and enrichment of the learning environment, more minority teachers

> teaching science and mathematics in better ways, more attention to the quality of the school environment, more minority students staying in school and taking science and mathematics courses at a more advanced level, more leaning of the organizational and intellectual processes that underly scientific inquiry at the same time that factual information from science and mathematics is being conveyed, more improvement in minority scores on the indicators of readiness for college study, and more financial resources committed earlier to assure that every minority student who has the desire and ability to pursue postsecondary study in science or engineering can do so. Every button needs to be pushed.[203]

If population trends continue as expected and if the participation of minorities in the sciences remains abnormally skewed, then the availability of an educated, scientifically literate workforce needed to meet the challenge of a highly competitive internal economy will continued to be at risk. Walter E. Massey, vice-president for research at the University of Chicago, and for the Argonne National Laboratory and recent nominee of President George Bush to be the Director of NSF, noted that this is an opportune time for groups involved in equity issues to promote science education among minorities, women and the handicapped. He posited that if the underrepresented in the sciences cannot be expanded, universities and private industries will fill the needed positions with foreign talent.[204] There should be two goals in science education, (1) to guarantee a high level of scientific and technical literacy for all students, and (2) to develop the talents of those who demonstrate the aptitude who are females and members of a minority group. These two goals should be pursued in concert.

The 101st Congress has introduced various legislation to respond to the Nation's need for trained scientific and technical personnel and the need for scientific literacy of the workforce and general citizenry. (For discussion of the legislation, see Congressional Research Service, Issue Brief--Science, Engineering, and Mathematics Precollege and College Education).[205] In

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[203] Johnson, David. Strengthening and Enlarging the Pool of Minority High School Graduates Prepared for Science and Engineering Career Options. Prepared for the Black Caucus Legislative Weekend Symposium on Opportunities and Challenges for Minorities in Science and Technology: Preparing for the Year 2000. Sept. 16, 1988. p. 4.

[204] U.S. Dept. of Energy. Math/Science Education Action Conference. Presentation of Walter E. Massey. Lawrence Berkeley Laboratory. Berkeley, Ca., Oct. 8-10, 1989.

[205] U.S. Library of Congress. Congressional Research Service. Science, Engineering, and Mathematics Precollege and College Education, by Christine M. Matthews. CRS Issue Brief No. IB88078, July 26, 1990. p. 15. [continously updated]

addition, much of the legislation has components that would contribute to the recruitment of minorities and women in the sciences. Congress might consider expanding its role by developing programs in Federal agencies and forming alliances with the private sector to further increase the number of students choosing science, mathematics, and engineering as a career. Because of the number of years it takes to "grow" a scientist, mathematician, or engineer, programs need to be proposed at all levels of the educational system--precollege, undergraduate, and graduate level.

APPENDIX

TABLE A1.
Women Minorities, and Foreign Nationals Enrolled in Engineering
1987-1988

	Women		Blacks		Hispanics*		American Indians		Asian/ Pacific		Foreign/ National	
	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988
FULL TIME UNDERGRADUATES:												
First Year	15,004	15,837	6,145	7,075	4,465	4,872	354	433	7,074	7,510	3,930	3,848
Second Year	11,820	11,465	3,777	3,911	3,424	3,221	215	209	6,015	6,174	4,402	3,817
Third Year	11,775	11,356	3,298	3,357	3,396	3,315	228	212	6,984	7,101	5,638	5,148
Fourth Year	15,640	15,011	3,892	3,697	4,456	4,228	325	302	9,441	9,227	7,831	7,595
Fifth Year	1,232	1,103	188	187	1,390	1,391	14	8	616	340	432	327
Total Full Time Undergraduates	55,471	54,772	17,300	18,227	17,131	17,027	1,136	1,164	30,130	30,352	22,233	20,735
Part Time Undergraduates	4,810	5,616	1,842	2,178	1,122	1,673	109	120	2,665	3,699	1,781	1,622
FULL TIME GRADUATE STUDENTS:												
M.S. or Prof. Engineering	5,546	5,813	626	651	878	752	66	70	2,818	2,875	14,697	15,690
Doctorate	2,533	2,960	165	215	254	310	25	31	1,497	1,789	12,251	13,867
Total Full Time Graduates	8,079	8,773	791	866	1,132	1,062	91	101	4,315	4,664	26,948	29,557
Part Time Graduate Students	5,836	6,545	888	899	700	697	56	70	3,590	3,645	5,221	5,871

*Includes 4,150 full-time undergraduates, 118 part-time undergraduates, 113 full-time graduate students, and two part-time graduate students at the University of Puerto Rico in 1987, and 3,889 full-time undergraduates, 99 part-time undergraduates, 102 full-time graduates students, and one part-time graduate student at the same institution in 1988.

SOURCE: American Association of Engineering Societies. Engineering Manpower Bulletin. Washington, May 1989. p. 3.

TABLE A2
Engineering Degrees Awarded to Women, Ethnic Minorities, and Foreign Nationals 1986-1988

		Under-Represented Minorities						
Level/Discipline		All Women	Blacks	Hispanics*	American Indians	Subtotal	Asian Americans	Foreign Nationals
All B.S. Degrees:	1986	11,264	2,114	1,864	129	4,107	4,824	6,275
	1987	11,675	2,182	1,840	149	4,171	5,056	6,048
	1988	10,940	2,211	1,920	187	4,318	5,591	5,763
Electrical	1986	2,755	806	598	44	1,448	2,348	2,165
	1987	3,173	853	615	54	1,522	2,674	2,251
	1988	3,177	850	640	54	1,544	2,887	2,229
Mechanical	1986	1,727	430	328	21	779	671	942
	1987	1,724	383	374	28	785	701	855
	1988	1,772	421	373	32	826	821	873
Civil	1986	1,091	168	255	14	437	352	1,425
	1987	1,096	200	226	18	444	354	1,194
	1988	1,072	179	243	36	458	359	950
Chemical	1986	1,483	194	102	13	309	297	281
	1987	1,379	182	106	10	298	231	237
	1988	1,079	164	99	11	274	234	261

TABLE A2.
Engineering Degrees Awarded to Women, Ethnic Minorities, and Foreign Nationals 1986-1988

Level/Discipline		Under-Represented Minorities						
		All Women	Blacks	Hispanics*	American Indians	Subtotal	Asian Americans	Foreign Nationals
Computer	1986	1,045	91	117	10	218	482	381
	1987	1,072	133	124	12	269	450	443
	1988	797	117	109	15	241	438	422
Industrial	1986	1,266	168	164	7	339	179	378
	1987	1,383	190	122	3	315	181	369
	1988	1,283	223	148	3	374	183	383
All Others	1986	1,897	257	300	20	577	495	703
	1987	1,848	241	273	24	538	465	699
	1988	1,760	257	308	36	601	669	645
M.S./Prof. Engineer	1986	2,745	345	322	27	694	1,704	5,735
	1987	3,119	366	382	33	781	1,774	6,315
	1988	3,378	365	469	32	866	1,785	7,329
Doctorates	1986	246	17	38	4	59	229	1,441
	1987	296	18	25	6	49	234	1,800
	1988	313	29	36	3	68	275	2,033

* Excludes degrees from the University of Puerto Rico, in order to restrict data on the 50 states and the District of Columbia.

SOURCE: American Association of Engineers Societies. Engineering Manpower Bulletin. Washington, Mar. 1989. p. 5.

TABLE A3.
Percentage Distribution of Full-Time Regular Faculty, by Ethnicity and Department Program Area: Fall 1987

Four-Year Institution	Full-Time Regular Faculty		Race/Ethnicity of Full-Time Regular Faculty				
			American Indian	Asian	Black	Hispanic	White
	Number	Percent	Percent	Percent	Percent	Percent	Percent
	378,732	100	1	5	3	2	89
By Program Area							
Agriculture and Home Economics	10,912	100	2	1	<1	3	94
Business	24,329	100	1	9	3	1	86
Education	24,464	100	1	1	7	3	88
Engineering	18,682	100	0	15	1	1	83
Fine Arts	24,789	100	1	2	3	3	91
Health Sciences	78,927	100	1	7	3	1	88
Humanities	47,426	100	1	2	3	4	91
Natural Sciences	60,347	100	1	7	1	2	89
Social Sciences	40,369	100	1	2	5	2	89
Other Fields	48,488	100	1	4	6	1	88

NOTE: Details may not add due to rounding.

SOURCE: U.S. Dept. of Education. Office of Educational Research and Improvement. National Center for Educational Statistics. Faculty in Higher Education Institutions, 1988. NCES 90-365, Mar. 1990. p. 11.

TABLE A4.
Percentage Distribution of Part-Time Regular Faculty, by Ethnicity and Department Program Area: Fall 1987

Four-Year Institution	Full-Time Regular Faculty		Race/Ethnicity of Part-Time Regular Faculty				
			American Indian	Asian	Black	Hispanic	White
	Number	Percent	Percent	Percent	Percent	Percent	Percent
	80,877	100	2	5	4	2	87
By Program Area							
Agriculture and Home Economics	–	–	–	–	–	–	–
Business	5,219	100	0	0	1	0	99
Education	4,233	100	3	4	9	3	81
Engineering	–	–	–	–	–	–	–
Fine Arts	8,506	100	0	5	2	4	89
Health Sciences	17,214	100	1	10	13	4	72
Humanities	8,598	100	0	3	3	2	93
Natural Sciences	10,073	100	1	8	1	1	89
Social Sciences	5,693	100	14	7	5	0	74
Other Fields	16,557	100	1	0	1	1	97

–Too few cases for a reliable estimate.

NOTE: Details may not add due to rounding.

SOURCE: U.S. Dept. of Education. Office of Educational Research and Improvement. National Center for Educational Statistics. Faculty in Higher Education Institutions, 1988. NCES 90-365, Mar. 1990. p. 12.

TABLE A5.
Percentage Distribution of Full- and Part-Time Regular Faculty, by Gender and Department Program Area: Fall 1987

Four-Year Institutions	Full-Time Regular Faculty		Gender		Part-Time Regular Faculty		Gender	
			Male	Female			Male	Female
	Number	Percent	Percent	Percent	Number	Percent	Percent	Percent
	378,732	100	75	25	80,877	100	54	46
By Program Area								
Agriculture and Home Economics	10,912	100	63	37	–	–	–	–
Business	24,329	100	78	22	5,219	100	69	31
Education	24,464	100	62	38	4,233	100	43	57
Engineering	18,682	100	97	3	–	–	–	–
Fine Arts	24,789	100	76	24	8,506	100	30	70
Health Sciences	78,927	100	68	32	17,214	100	57	43
Humanities	47,426	100	70	30	8,598	100	33	67
Natural Sciences	60,347	100	85	15	10,073	100	59	41
Social Sciences	40,369	100	77	23	5,693	100	61	39
Other Fields	48,488	100	77	23	16,577	100	59	41

– Too few cases for reliable estimate.

NOTE: Details may not add due to rounding.

SOURCE: U.S. Dept. of Education. Office of Educational Research and Improvement. National Center for Education Statistics. Faculty in Higher Education Institutions, 1988. NCES 90-365, Mar. 1990. p. 13.

TABLE A6.
Enrollment in Historically Black Colleges and University by Race/Ethnicity
Fall 1976 to Fall 1987

Race/Ethnicity							Percentage	
	1976	1980	1982	1984	1986	1987	1986-1987	1976-1987
Number of HBCUs	105	102	100	104	104	100		
Total	212,120	222,220	216,570	216,050	213,093	217,367	2.0	2.5
Black, non-Hispanic	185,820	185,780	177,000	175,110	176,596	182,019	3.1	-2.0
White, non-Hispanic	18,390	21,480	23,040	23,450	22,651	23,225	2.5	26.3
Asian	610	1,340	1,050	1,350	1,237	1,187	-4.0	94.6
Hispanic	460	1,030	1,070	1,560	1,485	1,588	6.9	245.2
American Indian	180	400	570	240	552	519	-6.0	187.2
Nonresident Alien	6,660	12,200	13,840	14,340	10,572	8,829	-16.5	32.6

NOTE: Details may not add to total because of rounding.

SOURCE: American Council on Education. Office of Minority Concerns. Minorities in Higher Education. Seventh Annual Status Report, 1988. Washington, Oct. 17, 1988. p. 27.

TABLE A7.
Total Federal Obligations for Research and Development to Higher Education Institutions (HEIs) and Historically Black Colleges and Universities (HBCUs) 1978-1988

Fiscal Year	HEI Total $ Millions	HBCU Total $ Millions	HBCUs as % of HEI
1978	3,385.7	28.6	8.4
1979	3,873.5	a/	--
1980	4,160.5	36.5	8.8
1981	4,410.9	39.8	9.0
1982	4,554.5	40.5	8.9
1983	5,024.3	49.1	9.8
1984	5,448.8	50.3	9.2
1985	6,246.2	57.0	9.1
1986	6,456.7	57.0	8.8
1987	7,239.5	62.6	8.6
1988	7,717.1	62.8	8.1

a/ Data are not available.

SOURCE: U.S. National Science Foundation. Federal Support to Universities Colleges, and Selected Nonprofit Institutions: Fiscal Year 1988. Detailed Statistical Tables NSF 89-325. Washington, 1989. p. 23, 77; and Federal Support to Universities, Colleges, and Selected Nonprofit Institutions: Fiscal Year 1985. Detailed Statistical Tables. Washington, 1987. p. 61.

TABLE A8.
Federal Agency Programs Targeted at Minorities and Women
(continued)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

- Summer High School Apprenticeship Program (SHARP). FY91 (proposed): $510,000.
- Undergraduate Student Researchers Program. FY90: $1 million.
- Graduate Student Researchers Program. FY90: $2.2 million.

NATIONAL SCIENCE FOUNDATION

- Career Access Opportunities in Science and Technology for Women, Minorities and the Disabled (ACCESS): FY91 (proposed): $15 million.
- Alliances for Minority Participation (AMP). FY91 (proposed): $10 million.
- Research Careers for Minority Scholars (RCMS). FY91 (proposed): $8.8 million.

DEPARTMENT OF DEFENSE

- Science and Engineering Apprenticeship Program (summer).
- Historically Black Colleges and Universities/Minority Institutions Program.

ENVIRONMENTAL PROTECTION AGENCY

- Minority Research Grants. FY91 (proposed): $900,000.
- Minority Fellowships. FY91 (proposed): $115,000.
- Minority Summer Internships. FY91 (proposed): $140,000.

TABLE A8.
Federal Agency Programs Targeted at Minorities and Women[a]

ALCOHOL, DRUG ABUSE, AND MENTAL HEALTH ADMINISTRATION

- Minority Access to Research Careers (MARC). FY89: $1.3 million.
- Minority Fellowship Program (MFP). FY89 $1.7 million.
- Minority Institutions Research and Development Program (MIRDP). FY89: $950,000.

DEPARTMENT OF ENERGY

- High School Student Research Apprenticeship Program. FY91 (proposed). $400,000.
- Prefreshman Enrichment Program (PREP). FY91 (proposed): $1.4 million.
- Minority Honors Training and Industrial Assistance Program. FY91 (proposed): $431,000.

NATIONAL INSTITUTES OF HEALTH

- Minority Biomedical Research Support(MBRS). FY91 (proposed): $32.3 million.
- Minority Access to Research Careers (MARC). FY91 (proposed): $13.4 million.
- Research Centers in Minority Institutions (RCMI). FY91 (proposed): $25.8 million.

DEPARTMENT OF INTERIOR

- Historically Black Colleges and Universities Initiative (large science and engineering component) FY90-92: $15 million.

DEPARTMENT OF AGRICULTURE

- USDA/1890 Summer Intern Program FY91 (proposed): $1.5 million.
- USDA/1890 Liaison Officer Program. FY91 (proposed): $2 million.
- USDA/1890 Capacity Building Grants Program. FY91 (proposed): $11 million.

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[a] McIntosh, Hugh. New Series of Federal Programs Aims at Attracting Minorities. The Scientist, v. 4, May 28, 1990. p. 10.